UNIVERSITAT ROVIRA I VIRGILI

EVOLUTION OF THE TECHNICAL BEHAVIOURS DURING THE LATE PLEISTOCENE AND EARLY HOLOCENE IN NORTH-WESTERN THAILAND, WITH SPECIAL REFERENCE TO THE LITHIC INDUSTRY FROM THAM LOD ROCKSHELTER (DISTRICT PANG MAPHA, MAE HONG SON PROVINCE)

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THANON CHITKAMENT

Evolution of the Technical behaviours during the Late Pleistocene and Early Holocene in North-western Thailand, with special reference to the Lithic Industry from Tham Lod Rockshelter (District Pang Mapha, Mae Hong Son Province)

Doctoral Thesis by :

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FAIG CONSTAR que aquest treball, titulat "**Evolution of the Technical Behaviours during the late Pleistocence and Early Holocene in north-western Thailand, with special reference to the Lithic industry from Tham Lod Rockshelter (District Pang MaPha, Mae Hong Son Province)**", que presenta **Thanon Chitkament** per a l'obtenció del títol de Doctor, ha estat realitzat sota la meva direcció al Departament d'Historia i Historia de l'Art d'aquesta universitat i que acompleix els requeriments per poder optar a **Menció Internacional /European**.

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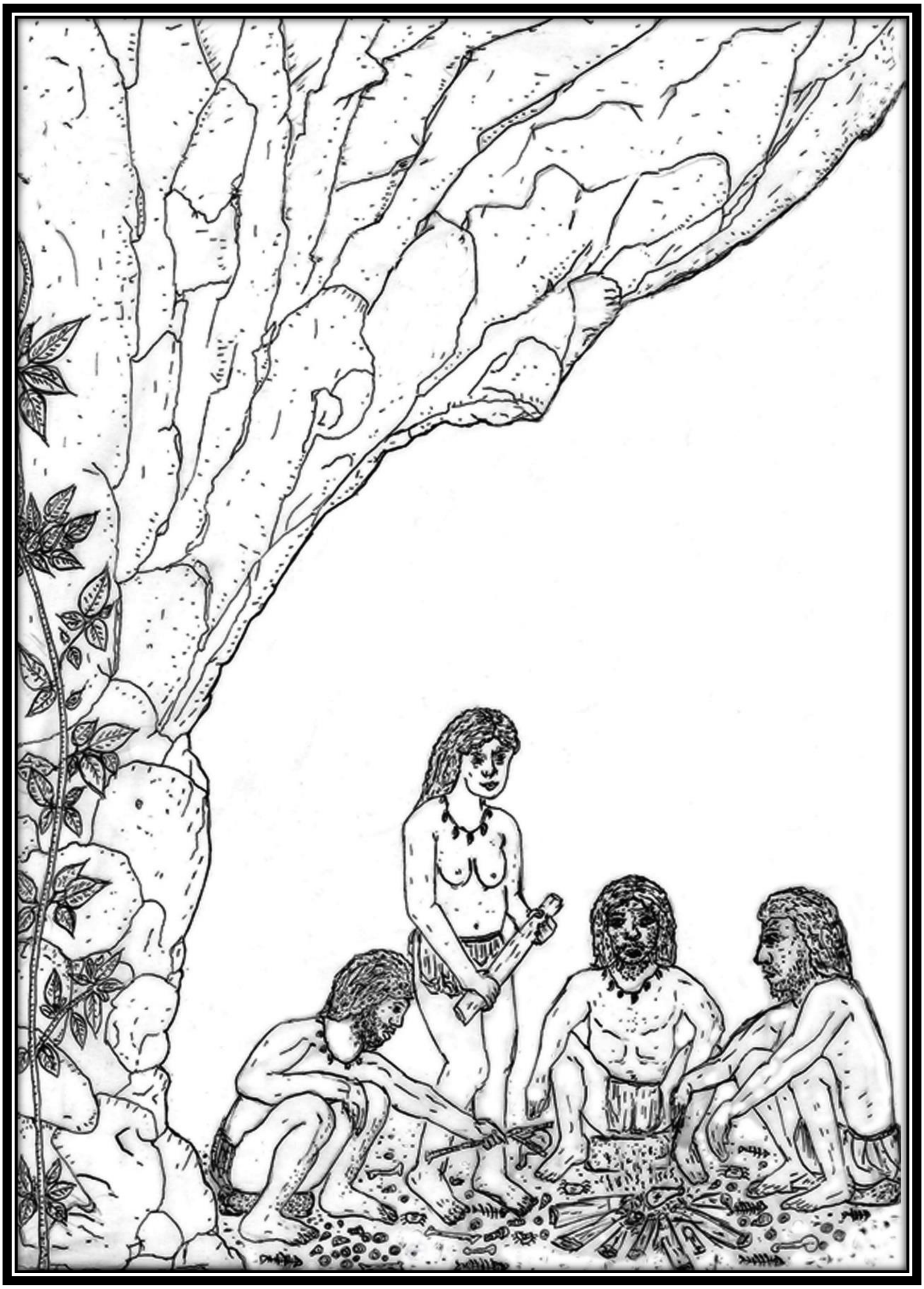
Directores de la tesi doctoral

Dr. Robert Sala i Ramos

Dra. Claire Gaillard



Dedicated to Dr. Surin Pookajorn and Dr. Plitadet Pholgerddee
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Thanon CHITKAMENT

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Abstract

This dissertation presents the analysis of lithic assemblages that have been unearthed from the late Pleistocene layers 3 to 10 of Tham Lod Rockshelter (excavation area 2, sectors S20W10 & S21W10). This limestone-karstic rock shelter is situated in Pang Mapha district of Mae Hong Son Province, north-western Thailand. On the lines of the research questions outlined by of *The Highland Archeological Project*, this site was excavated from 2002 to 2006 under the direction of R. Shoocongdej. The radiometric analyses provided dates ranging from late Pleistocene (35 ka, TL, which is one of the oldest dates for a prehistoric site in this region) to late Holocene (3000 years BP). The lithic and faunal remains occur in thousands throughout the stratigraphic sequence; ceramics and metal items appear in the upper layer (Holocene). Noteworthy are the few human burials in the late Pleistocene layers (13 ka BP).

The research has been able to establish that the artefacts are mostly made from local grey sandstone (more than 90%) available in the form of cobbles and pebbles in the nearby Nam Lang River. The lithic assemblage includes a large proportion (2/3) of sandstone fragments brought to the site and artificially (or thermally?) broken. These are mostly small fragments (<100 mm) while the large fragments are rare and even absent in the middle layers. Blank flakes are well represented in all the layers; among them, the large flakes (>100 mm) are almost absent. Cores (meant to produce flakes) are extremely rare. Actual tools (shaped or retouched) are less than 10 % of the material, half of them being longer than 100 mm. All of them, large and small, are mainly shaped on cobbles and cobble fragments and mostly with unifacial shaping.

Typical sumatraliths, the signature of the Hoabinhian technical tradition, start appearing in the lower layers, yet seem to be absent in the very bottom layer 10; they become conspicuous in the layer 4 (around 24-20 ka). However, they decrease in proportion in the last Pleistocene layer 3 to the benefit of choppers. They are associated with partial sumatraliths (not shaped all around), approximately equally frequent. Conversely, core tools (>100 mm) are almost exclusively choppers in lower layers 10 to 8. The scrapers are the major type among the small tools (<100 mm) and their frequency is quite constant throughout the stratigraphy. They are mostly shaped on broken cobbles, except in the layer 10 where the very few ones are on flake or fragment. Other small tools like denticulates, pointed tools and “atypical small tools” are not frequent in the studied material.

As some of the artefacts from Tham Lod Rockshelter are typically referring to the Hoabinhian, the detailed technological study of lithic industry helps in understanding this “techno-cultural” facies and in tracing how the stone artefacts were manufactured, by the hunters-gatherers. Former studies of the stratigraphy and geology of the site, as well as of the abundant animal remains of the late Pleistocene sequence had provided information regarding the environmental changes and shown that forests of various types were always present in the landscape, though with different extent. Detailed analysis of the lithic assemblage highlights the gradual technical evolution during this time period, in the context of the late Pleistocene climatic changes, including the Last Glacial Maximum and late-glacial events, in this part of Southeast Asia currently under sub-tropical climate.

Résumé

Cette thèse présente l'analyse de l'ensemble du matériel lithique qui a été extrait des couches 3 à 10 du Pleistocène final de l'abri sous roche de Tham Lod (zone n°2, secteurs S20W10 et S21W10). Cet abri-sous-roche est localisé à la base d'une falaise de calcaire permien, au nord-ouest de la Thaïlande, dans le district de Pang Mapha de la Province de Mae Hong Son. Les fouilles de ce site ont eu lieu de 2002 à 2006 sous la direction de R. Shoocongdej, lors de son projet de recherches dénommé "Projet archéologique des Hauts Plateaux". Les analyses radiométriques ont fourni des dates allant du Pléistocène supérieur (35 000 ans B.P. - ce qui est une des périodes les plus anciennes dans cette région pour un site archéologique) à l'Holocène supérieur (3000 ans B.P.). Les restes lithiques et fauniques sont présents par milliers dans toute la séquence stratigraphique ; des éléments en métal et en céramique font leur apparition dans la couche supérieure (Holocène). Il faut souligner la présence de quelques sépultures dans les couches du Pléistocène final (13 ka B.P.).

Les artefacts sont surtout constitués de grès gris (plus de 90 %), disponible localement sous forme de galets dans la rivière Nam Lang toute proche. L'assemblage lithique comporte une forte proportion (2/3) de fragments de grès apportés sur le site et brisés artificiellement (ou thermiquement ?). Ce sont principalement de petits fragments (< 100 mm), tandis que les gros fragments sont rares et même absents dans les couches médianes. Les éclats non retouchés sont bien représentés dans toutes les couches ; parmi eux, les grands éclats (> 100 mm) sont presque totalement absents. Les nucléus (destinés à la production d'éclats) sont extrêmement rares. Les outils proprement dits (façonnés ou retouchés) représentent moins de 10 % du matériel, la moitié d'entre eux étant supérieurs à 100 mm de long. Tous les outils, grands et petits, sont surtout façonnés sur galets ou fragments de galet, généralement sur une seule face. Les sumatraliths typiques, signatures de la tradition technique hoabinhienne, commencent à apparaître dans les couches inférieures mais semblent cependant absentes dans la couche 10, la plus ancienne ; ces outils prennent une importance remarquable dans la couche 4 (environ 24-20 ka B.P.). Toutefois leur proportion décroît dans la dernière couche pléistocène, couche 3, au profit des choppers. Ils sont associés à des sumatraliths partiels (façonnés seulement sur une partie du pourtour), de fréquence comparable. A l'inverse, les outils nucléiformes (> 100 mm) sont presque exclusivement des choppers dans les couches inférieures 10 à 8. Les racloirs constituent le type principal parmi les petits outils (< 100 mm) et leur fréquence est assez constante dans toute la stratigraphie. Ils sont principalement façonnés sur des galets fracturés, sauf dans la couche 10 où les rares racloirs sont sur éclat ou fragment. Les autres catégories de petits outils comme les denticulés, outils pointus et « petits outils atypiques » sont rares au sein du matériel étudié.

Comme certains des artefacts de l’abri de Tham Lod font typiquement référence au Hoabinhien, l'étude technologique détaillée de l’industrie lithique aide à comprendre ce faciès "technico-culturel" et à reconstituer la manière dont les artefacts en pierre ont été fabriqués par les chasseurs-cueilleurs. Des études antérieures de la stratigraphie et de la géologie du site, ainsi que des abondants restes animaux du Pléistocène final, ont fourni des informations sur les changements environnementaux et ont montré que des forêts de types variés ont toujours été présentes dans le paysage, quoiqu’avec des extensions variables. L’analyse détaillée de l’assemblage lithique met en évidence l'évolution technique graduelle qui s’est produite durant cette période, dans le contexte des changements climatiques de la fin du Pléistocène, comprenant le Dernier Maximum Glaciaire et les événements climatiques tardi-glaciaires, dans cette partie de l'Asie du sud-est actuellement sous climat sub-tropical.

Resumen

Presentamos el análisis de los conjuntos de instrumentos líticos que han sido excavados en los niveles 3 al 10, de Pleistoceno superior, en el Abrigo Tham Lod (área de excavación 2, sectores S20W10 y S21W10). Este abrigo rocoso calizo de origen cárstico está situado en el distrito de Pang Mapha de la provincia de Mae Hong, en el noroeste de Tailandia. Siguiendo las indicaciones de investigación señaladas por *The Highland Archaeological Project*, este yacimiento fue excavado entre 2002 y 2006 bajo la dirección de R. Shoocongdej. Los análisis radiométricos proporcionaron fechas que van des del Pleistoceno superior (35 ka BP, usando TL; constituye una de las fechas más antiguas para un yacimiento prehistórico en esta región) hasta el Holoceno (3 ka BP). Los restos de instrumentos líticos y fauna se cuentan por miles a lo largo de toda la secuencia estratigráfica; mientras que la cerámica y el metal aparecen en el nivel superior (Holoceno). Son de destacar los pocos enterramientos humanos en los niveles de Pleistoceno superior (13 ka BP).

La investigación ha podido establecer que los instrumentos fueron producidos sobre una arenisca gris local (más del 90% del conjunto) disponible como cantos en el vecino río Nam Lang. El conjunto lítico incluye una proporción amplia (2/3) de fragmentos de arenisca aportados al yacimiento y artificialmente rotos (¿térmicamente?). En su mayor parte son pequeños fragmentos (<100 mm) mientras que son raros los fragmentos mayores e incluso inexistentes en los niveles medios. Las lascas en bruto están bien representadas en todos los niveles; de este grupo, las lascas grandes (>100 mm) están casi ausentes. Los núcleos (es decir, matrices para producir lascas) son extremamente raros. Los útiles auténticos (configurados o retocados) constituyen menos del 10% de todo el material, la mitad de los cuales son mayores de 100 mm. Todos ellos, grandes y pequeños, están configurados sobre todo sobre cantos y fragmentos de canto y son principalmente unifaciales.

Los sumatralitos típicos, definitorios de la tradición técnica Hoabinhiense, aparecen por primera vez en los niveles inferiores, aunque parecen estar ausentes en el nivel más bajo, el 10; y son destacados en el nivel 4 (alrededor de 24-20 ka). Sin embargo, reducen su proporción en el último nivel Pleistoceno, el 3, a favor de los chopper. Están asociados con sumatralitos parciales (no configurados en todo su perímetro), con una frecuencia casi idéntica. Por el contrario, los útiles sobre canto (>100 mm) corresponden de forma casi exclusiva a chopper en los niveles inferiores, entre el 8 y el 10. Entre los útiles pequeños (<100 mm) el tipo principal lo constituyen las raederas y su frecuencia es muy constante a lo largo de la estratigrafía. En su mayoría están configuradas sobre cantos fracturados, excepto en el nivel 10 en el que las pocas raederas son sobre lasca o fragmento. Otros útiles pequeños, como denticulados, herramientas apuntadas y "herramientas pequeñas atípicas" no son frecuentes en el material estudiado.

Como algunas de las herramientas del Abrigo de Tham Lod son típicas del Hoabinhiense, el estudio tecnológico detallado de la industria lítica ayuda a comprender esta facies "tecno-cultural" y a trazar cómo fueron elaborados los utensilios de piedra por parte de los cazadores-recolectores. Estudios anteriores sobre la estratigrafía y la geología del yacimiento, como sobre la abundante fauna de la secuencia de Pleistoceno superior proporcionaron información sobre los cambios ambientales y han mostrado que en el entorno hubo siempre bosques de varios tipos, aunque de extensión variable. El análisis detallado del conjunto lítico pone en evidencia la evolución técnica gradual a lo largo de este período de tiempo, en el contexto de los cambios climáticos del Pleistoceno superior, incluyendo el Último Máximo Glaciar y períodos tardiglaciares, en esta parte del Sureste asiático, caracterizada hoy en día por un clima subtropical.

Resum

Presentem l'anàlisi dels conjunts d'instruments lítics que han estat excavats en els nivells 3 al 10, de Plistocè superior, en l'Abric Tham Lod (àrea d'excavació 2, sectors S20W10, i S21W10). Aquest abric calcari d'origen càrstic està situat en el disctricte de Pang Mapha de la província de Mae Hong, en el nord-est de Tailàndia. Seguint les indicacions de recerca assenyalades per *The Highland Archaeological Project*, aquest jaciment fou excavat entre 2002 i 2006 sota la direcció de R. Shoocongdej. Les anàlisis radiomètriques van proporcionar dates que van del Plistocè superior (35 ka BP, mitjançant TL; constitueix una de les dates més antigues per a un jaciment prehistòric en aquesta regió) fins a l'Holocè (3 ka BP). Les restes d'instruments lítics i fauna es compten per milers en tota la seqüència estratigràfica; mentre que la ceràmica i el metall apareixen en el nivell superior (Holocè). Cal destacar els pocs enterraments humans en els nivells de Plistocè superior (13 ka BP).

La recerca ha pogut establir que els instruments foren produïts sobre un gres gris local (més del 90% del conjunt) disponible com a còdols en el riu Nam Lang veí. El conjunt lític inclou una proporció àmplia (2/3) de fragments de gres aportats al jaciment i artificialment fracturats (tèrmicament?). Majoritàriament són petits fragments (<100 mm) mentre que els fragments més grans són rars i fins i tot inexistents en els nivells mitjans. Les ascles brutes estan ben representades en tots els nivells; dins d'aquest grup, les ascles grans (>100 mm) són quasi absents. Els nuclis (entesos com a matrius per a la

producció d'ascles) són extremament rars. Els útils autèntics (configurats o retocats) constitueixen menys del 10% de tot el material; d'ells la meitat són més grans de 100 mm. Tots ells, grans i petits, estan configurats majoritàriament sobre còdol i fragments de còdol i són principalment unifacials.

Els sumatralits típics, definitoris de la tradició tècnica Hoabinhiana, apareixen per primer cop en els nivells inferiors, tot i que semblen absents del nivell més baix, el 10; i són destacats en el nivell 4 (en torn de 24-20 ka). Tanmateix, llur proporció es redueix en el darrer nivell Plistocè, el 3, a favor dels chopper. Estan associats amb sumatralits parcials (no configurats en tot llur perímetre), amb una freqüència quasi idèntica. Al contrari, els útils sobre còdol (>100 mm) corresponen de forma quasi exclusiva a chopper en els nivells inferiors, entre el 8 i el 10. Entre els útils petits (<100 mm) el tipus principal el constitueixen les rascadores i llur freqüència és molt constant al llarg de l'estratigrafia. Majoritàriament estan configurades sobre còdols fracturats, excepte en el nivell 10 en el que les poques rascadores que hi ha són sobre ascla o fragment. D'altres útils petits, com denticulats, eines apuntades i "eines petites atípiques" no són freqüents en el material estudiat.

Com algunes de les eines de l'Abric Tham Lod són típiques del Hoabinhià, l'estudi tecnològic detallat de la indústria lítica ajuda a comprendre aquesta fàcies "tecno-cultural" i a traçar com foren elaborats els estris de pedra per part dels caçadors-recol·lectors. D'altres estudis anteriors sobre l'estratigrafia i la geologia del jaciment, així com sobre l'abundant fauna de la seqüència de Plistocè superior van proporcionar informació sobre els canvis ambientals i han mostrat que en l'entorn hi va haver sempre boscos de tipus diversos, tot i que d'extensió variable. L'anàlisi detallada del conjunt lític posa en evidència l'evolució tècnica gradual al llarg d'aquest període de temps, en el context dels canvis climàtics del Plistocè superior, incloent-hi l'Últim Màxim Glacial i períodes tardiglacials, en aquesta part del Sud-est asiàtic, caracteritzada avui dia per un clima subtropical.

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CHAPTER I

Introduction

1.1 Introduction

Prehistoric human remains, which have been found in Southeast Asia, were not older than those of the Upper Palaeolithic period. Since the 1960s, there have been series of archaeology projects by foreign and native people interested in prehistory. A large number of prehistoric implements have been discovered at several archaeological sites, however dates are not older than late Pleistocene period (Pholgerddee 1981). In the last 25 years there has been a fruitful revival of prehistoric investigations in Southeast Asia. Modern humans are found to be present in the Sunda Land from around 50 ka (Demeter et al. 2012) and even earlier in Northern Philippines (Mijares et al. 2010).

During the Late Pleistocene and early Holocene, Mainland Southeast Asia was inhabited by people making and using a particular type of industry called Hoabinhian. It was first discovered and defined by Madeleine Colani (1927). She excavated several Hoabinhian sites like limestone caves of Ton Kin, in North Vietnam (Colani 1926, 1927a, 1927b, 1931). At the same period, the Hoabinhian occurred in some parts of Thailand, especially in Kanchanaburi province (Western Thailand), in Lampang and Mae Hong Son provinces, (Northern Thailand), as well as in Krabi and Trang provinces (Southern Thailand). Recently, Hoabinhian excavations have been carried out in Mae Hong Son Province, North-western Thailand, where Shoocongdej R. has excavated three sites, namely Muang Pang Hot Spring, Ban Rai and Tham Lod Rockshelters. She has surveyed a large number of sites, outstandingly publishing a detailed report of her work (Shoocongdej 2001, 2002, 2003, 2004, 2005, 2007).

The main purpose of this work is to study the lithic assemblages from North-western Thailand, especially Tham Lod Rockshelter. The stone tool types are important to explain the functional orientations of the technique, including the selection of the materials. These artefacts, along with other traces of anthropic activities such as fire pits, ashes, faunal and floral remains convey a part of learning abilities of the prehistoric people in their daily life and suggest how their behaviours could survive in that time. Also, the environment underwent drastic changes during that period. Therefore, its important role should be studied because it can give archaeologists more insights into the past of prehistoric human.

1.1.1 Nature and Scope of subject

North-western Thailand is characterized by limestone mountain ranges that extend in a north-south direction. The topography of this area is approximately 90 percent mountains (highland limestone) and 10 percent valleys preserving high and low alluvium (Kiernan et al. 1988; Khaokhiew 2003, 2004; Shoocongdej 2006; Marwick 2008). Karst topography contains many caves and rockshelters in the Permian limestone which were occupied during the prehistoric period (Khaokhiew 2003, 2004). The highland here refers to high-altitude environments at elevations around 1000 meters above present sea level. This area has a tropical monsoon climate- with well pronounced wet and dry seasons; various types of forest are the main component of the vegetal cover (Khaokhiew 2003, 2004; Shoocongdej 2006; Wattanapituksakul 2006). Recently, the vegetation frequently changed in this area, as some part of the mountains and undulating terrain has been shifted to rice cultivation and plantations. The Quaternary rocks comprise sandstone, siliceous limestone, quartz, quartzite, mudstone, andesite, haematite, phtanite, etc., which have been used as raw materials by the prehistoric knappers.

Tham Lod Rockshelter is a prehistoric site located in Tham Lod Village, Pang Mapha district, Mae Hong Son province, near the border between Thailand and Myanmar. The site is a small rockshelter settled at the base of an overhang of a Permian limestone cliff. At present it is in the terrain of the Tham Lod Natural and Wildlife Education Center. The shelter is facing north (open area with a floor space) and widely opening on a forested landscape, located 640 meters above sea level, and 3 meters above the base of the cliff (Shoocongdej 2002, 2003, 2004, 2006, 2007; Khaokhiew 2003, 2004). Tham Lod Rockshelter was excavated from 2002 to 2006 in the context of the Highland Archaeology Project conducted by R. Shoocongdej, which has been supported by Thailand Research Funds (TRF) and Silpakorn University. The site is a stratified archaeological sequence, and it is one of the most well- known prehistoric sites in North-western Thailand, mainly for the burials it has yielded.

The excavation of Tham Lod Rockshelter was carried out in three areas. Ten main layers were presumably distinguished from a 4.5 m thick stratigraphy (Khaokhiew 2003, 2004). Many datations have been processed on different materials and with different methods; they provided results ranging from *ca.* 35,000 years B.P to about 3000 years B.P. The site has well preserved faunal and floral remains (Pumijumnong 2003, 2006; Amphansri 2004, 2005, 2011; Wattanapituksakul 2006; Krajaejun 2007). It is considerably rich in industry, comprising mostly lithic artefacts and few bone tools (Kheawtaya 2005). Two burials and two more fragmentary skeletons were exposed in the area 1 near the wall of the rockshelter, in the final Pleistocene layers (Pureepatpong 2004, 2006). Significantly, freshwater shellfish remains were found associated with the first burial and a few large pebbles (Khaokhiew 2003, 2004; Amphansri 2004, 2005, 2011; Shoocongdej 2006; Pureepatpong 2006; Krajaejun 2007).

This work undertakes a study of the technical behaviour of prehistoric populations within a regional framework. Interpretation of the lithic industry at Tham Lod Rockshelter will be enhanced by the richness of the associated materials (faunal remains, including shells, and vegetal remains, mainly charcoal and pollens) within a well-defined stratigraphy. Interestingly, this site is one of the most important region-oriented work in hunter gatherer archaeology in North-western Thailand.

1.1.2 Aims and Objectives of Proposed study

The question of the relationship between human population and the environment has been studied and discussed, especially in terms of seasonal mobility (Shoocongdej 1996, 1996a, 1996b, 2000). This work is an attempt to develop a detailed analysis of the technology and typology in order to understand how the people, who occupied the Tham Lod Rockshelter, were making their implements from the available stone resources (production, maintenance and eventually re-sharpening), what type of tools they ordinarily preferred (small tool on flake or debris, large core-tool on cobble, other), how they were using them and what was the standard active edge of the tools. It also tries to study how these characters changed with time and environment. These has helped in precising the technological adaptation to the natural conditions. As some of the artefacts are definitely considered as Hoabinhian, the detailed technological study has helped in understanding this "techno-cultural" facies. Comparisons with other lithic assemblages from sites located in the tropical environment of neighboring regions in Southeast Asia has also contributed to this issue.

As the site has abundantly yielded more than 100,000 artefacts, it is necessary to focus on a sample. The center of the excavation has been selected for this: the study concentrates on the materials from the entire sequence of the sectors S20W10 (SEQ 3-4) and S21W10 (SEQ 3-4) in area 2.

The main objectives of this techno-typological study are:

1) To analyze in details the lithic industry from Tham Lod Rockshelter area 2, sectors S20W10 and S21W10 in order to reconstruct the technical process / processes used in each occupation layer.

2) To compare the technical features in the different layers in order to trace their evolution.

3) To study the distribution and characters of lithic assemblages in relation to the environmental and geological contexts.

4) To compare the lithic industry from Tham Lod Rockshelter with some other assemblages from northern and other parts of Thailand. Further geographical zones may also be considered.

1.1.3 Review of Literature

Chester Gorman (1970) had first conducted archaeological research in North-western Thailand, and he focused on the issue of the origins of plant domestication in Southeast Asia. Since Gorman's excavation at Spirit cave (1970), little research had been carried out on the late Pleistocene and early Holocene within the region ca. 40,000-7,500 B.P (Gorman 1971b, 1972). Most of the sites commonly yield Hoabinhian industries as for example in Kanchanaburi Province, Western Thailand: Sai Yok (van Heekeren and Knuth 1967; Mathews 1964) and Ban Kao (Sørensen and Hatting 1967; You-Di 1986), Khao Talu, Ment and Heap Caves (Pookajorn 1977, 1979, 1984), Ongbah Cave (Sørensen 1988) and perhaps Lang Kamnan Cave although typical Hoabinhian tools are missing (Shoocongdej 1996, 1996a, 1996b, 2000); in Lampang and Mae Hong Son provinces, Northern Thailand: Spirit Cave and Tham Phaa Chan (Gorman 1970; White & Gorman 1974, 2004; Bannanurag 1988), Banyan Valley Cave (Reynolds 1992), Obluang (Prishanchit & Pengtako 1984; Santoni et al. 1985, 1986, 1990), Ban Fa Suai in Chiang Dao and Huai Hin in Mae Sariang (Forestier et al. 2006, 2013; Zeitoun et al. 2008) and also in Krabi and Trang provinces, Southern Thailand, at Lang Rongrien (Anderson 1986, 1987, 1988, 1990), Moh Khiew (Pookajorn 1991, 1994, 2001; Auetrakulvit 1995; Thipkamjornwong 1997; Moser 2001; Chitkament 2007; Auetrakulvit et al. 2012), Sakai (Pookajorn 1991, 1994, 2001; Chaimanee 1994) and Khao Toh Chong (Marwick et al. 2013; Conrad et al. 2013; Van Vlack 2014).

More recently, Tham Lod and Ban Rai Rockshelters, Mae Hong Son province in North-west Thailand, were excavated in the context of the Highland Archaeological Project in Pang Mapha. Several progress reports including multidisciplinary studies have directly been submitted to the Thailand Research Funds (TRF) which mainly supported the project together with Silpakorn University (Shoocongdej 2001, 2002, 2003, 2004, 2005, 2007). Besides, many Thai researchers significantly contributed to these reports in different topics such as physical anthropology, dental anthropology, bioarchaeology, dendrochronology, palynology, ethnoarchaeology, lithic technology and geographic information systems (GIS) studies. For some of them, this work was part of their master thesis as for instance geoarchaeology (Khaokhiew 2003, 2004) and zooarchaeology (Wattanapituksakul 2006; Amphansri 2011). Some articles were also published on the general issues of this project (Shoocongdej 2003, 2004, 2006; Treerayapiwat 2005; Marwick 2008a, 2008b, 2008c; Marwick & Gagan 2011; Chitkament et al. 2015) and on the morphological analysis of the human remains from Tham Lod and Ban Rai Rockshelters (Pureepatpong 2006).

The lithic assemblages were presented in the final report of the excavation at Highland Archaeological in Pang Mapha (Phase II) by Shoocongdej (2007) yet without details regarding the technology and typology. Technology was elaborately studied from the experimental viewpoint by Marwick (2008) who also worked on the human behavioural ecology in northwest Thailand during the terminal Pleistocene and Holocene (Marwick 2008, 2008a, 2008b, 2008c; Marwick & Gagan 2011). Until now there is no detailed analysis of the technology, morphology and typology of lithic assemblages from Tham Lod Rockshelter; therefore, it is difficult to compare them with other prehistoric sites in Southeast Asia and South Asia.

1.1.4 Proposed Methodology

Basic artifact classification was carried out in the field following the system used by Shoocongdej (1996). Each piece was examined for a number of technological characteristics and coded as a waste core, utilized core, waste flake, utilized flake, resharpening flake, hammerstone, or grinding stone. Counts and weights for lithics, potshards and bones were completely recorded for each excavation area and each layer (Shoocongdej 2001, 2002, 2003, 2004, 2005, 2007). The key of Shoocongdej (1996, 2006) questions in this analysis is how the lithic artefacts were manufactured, used, maintained, and discarded.

These are the main questions. I propose to analyze in more details the technology and the typology of the lithic industry. Identification of the technical operational themes will be conducted in following adapted methodology from my Master dissertation entitled *Lithic analysis at Moh Khiew rockshelter "locality I" in Krabi river valley, Krabi province, South-western Thailand*. It is really based on the methodologies applied in the Department of History of Universitat Rovira i Virgili (URV), Tarragona, Spain (*the logical analytical system*), and in the Department of Prehistory of the National Museum of Natural History (MNHN), Paris, France.

In my study, the artefacts will be classified into eight morpho-technical categories such as flakes, cores, small tools, large tools (core tools), hammers, big fragments, small fragments and unmodified manuports:

- flakes (possibly utilised),
- cores: mainly for the flake production, without preferential worked edge but possibly utilised,
- small tools / light-duty tools: intentionally retouched flakes, fragments, small cobbles or pebbles; length < 10 cm,

- large tools / heavy-duty tools, mainly core tools: tools on cobbles or chunks showing a preferential edge which seems to have been intentionally shaped; length > 10 cm,
- hammerstones (with battering marks),
- big fragments (> 10 cm) and small fragments (< 10 cm): pieces of imported rocks, most of them probably flaked or knapped as suggested by the apparently intentional fractures, along with some thermally broken specimens,
- unmodified manuports: pebbles (water-worn nodules < 64 mm) and cobbles (water-worn nodules between 64 and 256 mm) sometime broken and utilized.

The statistic tools will be utilized as voluminous collections, which are almost impossible apprehend in a whole, could be well perceived in the light of percentages of their various typological, technical and morphological characteristics.

This study will help in establishing the technical evolutionary trends in Tham Lod Rockshelter and the relationship between the technical practice used at that time in the North-western Thailand and in other parts of Thailand (and Southeast Asia). Assessing the developments of industry and lithic technology undoubtedly helps to understand the human occupation and the human behaviours in district Pang Mapha, North-western Thailand. In addition, the use of published and unpublished ethnographical accounts, monographs and field's reports in the region – all from the Highland Archaeological Project (2001-2006) - will be taken as references.

1.1.5 A schedule for PhD project

I would like to thank Professor Rasmi Shoocongdej, the leader of Highland Pang Mapha project, for her generosity. She permitted me to work on the lithic materials at Tham Lod Rockshelter, district Pang Mapha, Mae Hong Son province. Before analysis of the stone artefacts, a study of the site of Tham Lod, particularly the archaeological remains has been made. The publications at the Silpakorn University Library were consulted for one month. The progress reports submitted to Thailand Research Funds (TRF) and to Silpakorn University have been thoroughly scrutinised. On this basis a central area of the excavation, which had more concentration in lithic artefacts, has been chosen for a detailed study.

The area 2 of Tham Lod Rockshelter has been selected for this doctoral dissertation. This area is located between the areas 1 and 3. The material from this area can be considered as a sample from Tham Lod Rockshelter. It was not selected at random but from the centre of the excavation: sectors S20W10 and S21W10. All the stone artefacts from the upper to the lower layers of these sectors have been analyzed. Besides, it should be kept in mind that the activities of the prehistoric dwellers were certainly not the same close to the wall, just below the overhang of the cliff (area 1), and some 10 to 20 m apart (area 2 and area 3): faunal remains, especially, are much more abundant in the area 1 (Khaokhiew 2003, 2004; Shoocongdej 2003, 2004, 2006; Kheawtaya 2005; Wattanapituksakul 2006); this is also the area where the burials were found (Pureepatpong 2004, 2006).

In May 2010, a visit to Tham Lod (Pang Mapha district, Mae Hong Son Province) was made and the lithic material stored at Wildlife Education Center, near the Tham Lod Rockshelter (approximately 100 m) was organised and arranged for analysis. The collected material from the three trenches was kept in big bags, approximately 30-40 kg, each bag labelled with information of the provenance level. After sorting out, the lithic artefacts from area 2, were taken out from the store: this amounted a total of 160 bags, which represent several thousand artefacts. Then they were classified according to the following categories: blank flakes, tools (large & small tools), hammerstones, big fragments, small fragments and unmodified manuports (pebbles and cobbles). They were also sorted out according to the ten stratigraphic layers (2 to 10). For organizing the lithic material, it took almost 3 months.

In January 2011, the analysis of the stone assemblage from sector S20W10 (SEQ 3-4) was started. A total of 7571 items have been studied. Out of these, there were 1004 flakes, 566 all tools (large and small tools), 3 cores, 726 hammers, 141 unmodified manuports (pebbles and cobbles), 346 big fragments and 4785 small fragments. For all these works, it took approximately 4- 5 months to analysis of the lithic artefacts and around 2 months to illustrate the cobble tools.

Later on, in February 2012, analysis of the stone assemblage from sector S21W10 (SEQ 3-4) was resumed. A total of 4276 specimens have been collected from this sector. Out of these, there were 520 blank flakes, 284 tools (large and small tools), 4 cores, 39 hammers, 144 unmodified manuports (pebbles and cobbles) and 3285 small fragments. It is to be noted that no big fragments have been discovered from this sector. It took approximately 4-5 months to analyse the stone artefacts from this sector, including the drawing of some cobble tools.

In the middle of September 2012, I returned in France to concentrate on the writing and discussing the results in order to understand better the humans who occupied Tham Lod Rockshelter during late Pleistocene.

Meanwhile, a preliminary analysis of the lithic assemblage from sector S20W10 (about 7500 specimens) was presented in September 2012 at the Euraseaa-14 Conference in Dublin. Results of the study of both sectors S20W10 and S21W10 combined were presented in a poster at the International Union for Prehistoric and Protohistoric Science, in September 2014 at Burgos, Spain. Then recently, the choppers, sumatraliths and other heavy-duty tools were presented at the Euraseaa-15 Conference in July 2015, at the University Paris Ouest Nanterre la Défense. Following these presentations, two articles have been submitted:

CHITKAMENT T., GAILLARD C. & SHOOCONGDEJ R. (submitted in 2012) Evolution of the lithic industry from Tham Lod Rockshelter (Pang Mapha district, North-western Thailand) during the Late Pleistocene: preliminary results. *In*: Lewis H. (ed.), Selected Papers from the 14th International Conference of the European Association of Southeast Asian Archaeologists, NUS Press, Singapore.

CHITKAMENT T., GAILLARD C. & SHOOCONGDEJ R. (in press).
Tham Lod Rockshelter (Pang Mapha district, North-western Thailand): Evolution of the lithic assemblages during the Late Pleistocene. *Quaternary International* http://dx.doi.org/10.1016/j.quaint.2015.10.058

1.1.6 Organisation of the Dissertation

1. Introduction

Chapter 1 introduces the basic idea behind this research; it spells out the aims and purposes of the work, and a brief review of the history of prehistoric research in Thailand, including summary of the Hoabinhian sites and the chronological sequences of prehistoric sites in Thailand.

2. Presentation of Tham Lod Rockshelter and excavation materials in Highland Pang Mapha, Mae Hong Son province, North-western Thailand

Chapter 2 deals with the details of the Tham Lod Rockshelter and excavation materials. It begins with the general contexts *such as* geographical outline of Northern Thailand, followed by the geographical and environmental setting in Mae Hong Son Province (recent climate seasonality, recent forest and vegetation resources, recent faunal resources). The main matter is focused on the excavation area, starting with an overview of the Highland Pang Mapha, which gives details on the geology, geomorphology, geographical feature and environmental setting of the research area (Ban Tham Lod) and then presenting the excavation method, the stratigraphic sequence and the description of the archaeological material.

3. Methodology for Technical and Typological analysis of the lithic assemblages from Tham Lod Rockshelter

Chapter 3 outlines the framework of the research and explanation about the methodology used: the lithic technology, the lithic raw materials used for the manufactures and lithic reduction sequence. The principal focus of this chapter is on the morpho-typological and technological analysis: typological classification, sample selection and criteria for stone artefact analysis.

4. Analysis of the Lithic Materials from Tham Lod Rockshelter Area 2, sectors S20W10 (SEQ 3-4) and S21W10 (SEQ 3-4)

Chapter 4 deals with the analysis of the lithic artefacts in area 2 of Tham Lod Rockshelter. The chapter starts with the scope and the limit of the study, and presents the distribution of the different categories of the lithic artefacts in sectors S20W10 and S21W10. Then each category is analysed: blank flakes, large tools (choppers: end choppers, side choppers and other chopper), small tools (scrapers: end scrapers and side scrapers, denticulates, pointed tools and atypical small tools), sumatraliths (typical sumatraliths and partial sumatraliths), hammerstones, big fragments, small fragments and unmodified manuports (pebbles and cobbles) from both sectors.

5. Comments and conclusion

Chapter 5 outlines the archaeological materials from Tham Lod Rockshelter, particularly the significance of cultural behaviour during late Pleistocene to early Holocene. It also deals with the overall composition of the lithic assemblage from area 2, sectors S20W10 and S21W10 in Tham Lod Rockshelter, in relation with the paleoenvironment and paleoclimate. The experimental replication helps to understand the concept of typological and functional production of the stone artefacts, and manufacturing of tools by using modern materials, by different techniques. This chapter is the summary of the research by identifying the stone tool assemblage from Tham Lod Rockshelter, and highlighting the prehistoric human behaviour in district Pang Mapha, North-western Thailand.

1.2 Historical review of Prehistoric Researches in Thailand during the Last Eighty Years

H.R.H. Prince Damrong (1934) initiated the first study of prehistoric archaeology in Thailand. He is well known as the father of Thai Archaeology and History even before 1934. Later, many foreign scholars were interested in Thai prehistory and undertook several explorations in Thailand as reported in some bulletins and journals in their countries (Pholgerddee 1981). Hence, to report the progression and development of Thai prehistory research during the last eighty years, I divide it into four phases as follows:

First phase covered the period from when Monsieur Lunet de Lajonquiere found cave painting in Southern Thailand up to when N.R Van Heekeren discovered the Palaeolithic artefacts in upper layer of the river gravels and boulders from Ban Kao sites in Kanchanaburi province, Western-Thailand.

Figure 1.2.1 Photograph of Prince Damrong Rajanubhab, Son of King Mongkut (Rama IV) (Source: https://en.wikipedia.org/wiki/Damrong_Rajanubhab)

1922: The archaeological research in Thailand was first undertaken by French archaeologist, Mousieur Lunet de Lajonquierre. He explored prehistoric rock paintings at Krabi and Phang Nga Bay, Krabi province in Southern Thailand, and published in the bulletin of la Commission Archaeologique de l´ Indo-Chine, 1922 (Kerr 1924; Sarasin 1959; Pholgerddee 1981).

1924: Kerr explored the Rock painting of unknown age in Eastern-Thailand and also published in Journal of the Siam Society 18.2.1924. Besides, he had written "*So far (1924) no Palaeolithic implements have been found within the confines of the present day Siam (Thailand). Further, as no systematic research work has hitherto been undertaken, there may be lying a rich harvest, only awaiting discovery, especially in the caves which abound in the limestone hills in Western and Northern Siam*" (Kerr 1924; Pholgerddee 1981).

1924: Sarasin (Evans 1926) also found some polished adzes in southern Thailand.

1927-8: Dr. Davidson Black from Medical College of Peking, China, came to Thailand for searching skeletons, similar to those of *Homo erectus* that had been explored at Choukoutien Cave, Peking. But, he found nothing in Thailand (Sarasin 1959; Pholgerddee 1981).

1930: Kerr and Seidenfaden discovered stone tools, adzes and cord-marked pottery at Suratthani province, Southern Thailand (Kerr 1924; Pholgerddee 1981; Pookajorn 1984, 2001).

1931: Sarasin F., (Swiss Anthologist) conducted excavations at various caves in Chiang Mai, Lop Buri and Ratchaburi provinces. He is considered to be the first person, who discovered implements belonging to a culture known as "*Siamian*." A few quite amorphous tools were displayed such as two or three pebbles with unifacial flaking. The tool assemblages were either of the Palaeolithic chopper -chopping tool tradition, or were "Mesolithic" and "Hoabinhian" (Sarasin 1933: 171-202; You-Di 1978; Pholgerddee 1981; Pookajorn 1988).

1933: Neolithic polished stone axes and potteries recovered during exploration at Nakhon Sawan, Lop Buri, Nakhon Si Thammarat, Trang, and Krabi provinces, etc., were entirely exhibited in the National Museum, Bangkok, Thailand (You-Di 1978; Pholgerddee 1981).

1943-4: H.R van Heekeren was a prisoner of war under Japanese authority and working on the railroad construction from Nong Pla Duk to Moulsein in Burma. The railroad really passed through the city of Kanchanaburi up to the valley of the Kwae Noi river near Ban Kao village, where there was exposed pebble field. He managed to pick up six specimens and was able to keep three of the artefacts, until the end of the war. These implements were published as the first Palaeolithic artefacts known from Thailand (van Heekeren 1947b, 1962; You-Di 1978; Pookajorn 1977, 1984, 1988; Pholgerddee 1981).

Second phase of Thai prehistory was called the "growing phase". This phase began after the discoveries of chopper-chopping tool complex at Ban Kao in Kanchanaburi province by H.R van Heekeren and continues up to the explorations organized by the prehistoric section of the Fine Arts Department in Bangkok. This period stimulated foreign and Thai archaeologists to undertake and explorations in western and other parts of Thailand.

Figure 1.2.2 Photograph of H.R. van Heekeren (Netherlander archaeologist) (source: https://www.google.fr/search?q=H.R+van+Heekeren+Thailand)

1947: H.R van Heekeren published the Palaeolithic tools findings of Thailand in London illustrated, issued on April 5, 1947 (van Heekeren 1947b: 24-32; Pholgerddee, 1981). Movius, H.L., (1948), and Peabody Museum, U.S.A., reported the Palaeolithic tools finding of Thailand in "*The Lower Palaeolithic culture of Southern and Eastern Asia*."

1955: The Division of Archaeology at the National Museum of Bangkok explored the Palaeo -skeleton in Kao Trom Cave, Surat Thani province, Southern Thailand. The human remains were sent to Dr. Sood Sangvichien, Anatomy Department, Medical University, and Bangkok (Chin You-Di 1978; Pholgerddee 1981). In the same year, the National Museum, Bangkok obtained the assemblages to add in the collection, including a first shouldered axe found in Surat Thani Province, Southern Thailand.

1956: Heider K.G (American archaeologist), a student of Movius, H.L., was working together with some Thai staffs from Archaeological Division and the Fine Arts Department. They discovered the Ban Kao and Tha Kilen district, and found 104 pebble tools, and 4 flakes at Kwae Noi valley (You-Di 1978; Pholgerddee 1981). These artefacts were exhibited at eight localities near Ban Khao and Tha Kilen, from two small villages, on the railway line from Kanchanaburi to Sai Yok district. Besides, most of the artefacts had been standardized as the Hoabinhian types and a few of flatter specimens could be called "*Sumatraliths*" (Heider 1958, 1960; You-Di 1978; Pookajorn 1977, 1984, 1988).

1960-2: A Thai-Danish prehistoric team consisting of Bigil Bielson, Count Bigil Knuth, Per SØrensen with their staffs from Denmark, H.R van Heekeren from Holland, Sood Sangvichien (Medical University), Tom Smittinan (Forest Department) and Chin You-Di, (Thai Archaeological Division) from Thailand explored the banks along the Kwae Yai and Kwae Noi rivers and especially conducted four excavations at Ban Kao, Chande, Tham Pra and Sai Yok sites. In addition, the rock painting was discovered at Roop cave near Sai- Yok site (Nielsen 1962; SØrensen 1974; You-Di 1978, 1986).

Figure 1.2.3 Photograph of Chin You-Di (Thai archaeologist) (Source: https://www.google.fr/search?q=Chin+Yudee+Thai archaeologist)

1963-5: American-Thai expedition organized by anthropologists from Hawaii University and Thai archaeologists from the Fine Arts Department consisting of Solheim W.G., Bayard D.T., Gorman C.F, Green E. (U.S.A), Chin You-Di, Vidya Intakosai and staffs (Thailand), mainly worked in Udon Thani, Khon Kaen, Sakon Nakhon and Kalasin provinces, North-eastern Thailand. They explored important archaeological sites, rock painting caves and carved walls. Concurrently, Bayard D.T., and Gorman C.F., made an expedition in North Thailand (Solhiem 1970, 1972a, 1972b; Bayard 1968, 1970; You-Di 1978; Pholgerddee 1981; Pookajorn 1988).

Third phase developed with improvement of technical practices in the archaeological fields, learnt outside Thailand by most of the Thai archaeologists. Several prehistoric sites were explored and excavated by foreign and native people in various parts of Thailand.

1965-6: Gorman C.F. conducted archaeological field survey and excavations in Northern Thailand. During his Ph.D work at the University of Pennsylvania, he excavated a series of one meter square at Spirit cave. Two main cultural levels were really defined in deep of soil deposit, and fourteen radiocarbon samples had been submitted in the result. The excavated materials were estimated around 12,000-7500 B.P (Gorman 1968, 1970, 1971b, 1972, 1977; Reynolds 1989, 1990, 1992; Pookajorn 1986, 1988; Shoocongdej 1996).

1966 & 1968: German geologists, Koch K.E and M. Siebenhuener investigated mineral resources in Northern Thailand. They discovered several locations with stone artefacts. Most of the artefacts were pebble tools, which looked like chopper-chopping tools along with "*Sumatraliths*" of Hoabinhian types (Koch and Siebenhuener 1969; Pholgerddee 1981; Pookajorn 1985, 1986, 1987, 1988).

Figure 1.2.4 Photograph of Chester Gorman (American- archaeologist) (Source: https://en.wikipedia.org/wiki/Chester_Gorman)

1970: Veeraphan Malaiphan of the Archaeological Department, Silpakorn University, Bangkok, Thailand- discovered Palaeolithic tools at Chai Seen district, Chaing Rai province, Northern Thailand (Malaiphan 1972; Pookajorn 1988; Shoocongdej 1996).

1971: Gorman C.F. explored a prehistoric site at Banyan Valley in Mae Hong Son Province, North-western Thailand. Latter, the Steep Cliff and Banyan Valley caves were excavated by Gorman C.F. in 1972. These two caves were similar in terms of cultural materials and cultural sequences to Spirit cave (Gorman 1971b; You-Di 1978; Pookajorn 1984, 1988; Reynolds 1992).

1972: The Bo Ploi site, in the north of Kanchanaburi province, was re-visited by H.R van Heekeren and D.R. Hooijer. This surface was evident by its bifacial industry, which had been discovered by Vidhya Intakosai (1970). Generally, the site of Bo Ploi was undoubted as an industry of Holocene period, where the technique of tool making was similar to Pleistocene period. In fact, their intimate belongings to the line of the Hoabinhian industries and most of the bifacial tools are more than usual specialisation of light duty tools (Intakosai and Liere 1978; Pholgerddee 1981).

1972: Two excavations were organized under the project of the Ban Chiang's culture. The excavation at Ban Chiang, Udon Thani province and at Ban Sang Du, Sakon Nakhon province was advertent of the Archaeological Division staff, including Dr. Sood Sangvichien. The archaeological discovery included the Mesolithic implements from Nong Khai and Laei Provinces (You-Di 1978, 1986). In the same year, they explored some Mesolithic tools at Doi Saket Cave in Chiang Mai province, Northern Thailand (You-Di 1978, 1986; Pholgerddee 1981; Pookajorn 1988; Shoocongdej 1996).

1974: A trained group of archaeologists from Laos, Cambodia, and Vietnam led by Bayard D.T., at Otago University in New Zealand, discovered Mesolithic tools at Chaing Khon district and Chaing Mai province (Bayard 1968, 1970; Pholgerddee 1981).

1976: SØrensen and his geophysicist coworkers (Barr, Haile and Reynolds 1976) reported the discovery of Palaeolithic tools in the deposits at Mae Tha, Lampang province, Northern Thailand. The problems were really encountered in the use of various dating techniques. It was concluded that the basalts have a minimum date of about 690,000 B.P (Barr et al. 1976; Pope 1981; Charoenwongsa 1984; Charoenwongsa and Bronson 1988).

1977: Pookajorn excavated at Khao Talu, Ment, Heap and Pet Khuha caves near Ban Kao, Kanchanaburi province. These are famous Hoabinhian sites in western Thailand. The artefact assemblages such as Hoabinhian tools, shells, animal bone remains, grains, and fragments of pottery were discovered by the Archaeological department from Silpakorn University and students (Pookajorn 1977, 1979, 1984, 1988; Shoocongdej 1996).

Figure 1.2.5 Photograph of Surin Pookajorn (Thai archaeologist) (Source: http//www.rasmishoocongdej.com/about-archaeology-)

1980: The excavation was systematically done at Ban Tha Manao, Kanchanaburi province led by Pholgerddee and the Archaeological Department from Silpakorn University. The stone implements displayed were around 1778 pieces of tools. Besides, the predominant type of tools belonged to the chopper-pick type and the scraper group of the early and late Holocene period (Pholgerddee 1981).

Fourth phase was developed with modern techniques of work by Thai archaeologists which up continues up to the present day. A large number of prehistoric implements have been discovered for three decades in several parts of Thailand. Foreign and native people have been carrying out intensive study in these fields. However, for this phase, I will only present the archaeological work on the some Hoabinhian sites during the prehistoric period.

1983: Thai archaeologists led by Prishanchit, surveyed 52 sites at Muang and Khun Yuam district, Mae Hong Son Province. Most of the prehistoric sites had scattered stone implements. The stone flaking debris extend along hill ranges and mountains. After that, Thai-French archaeologists led by Santoni M., Pautreau J.P, Meadow R., and Prishanchit also resurveyed the same area and continuously explored other sites, which were quite similar to the shelters on the Doi Phutok at Ban Thung Phong, Sa district, Nan province (Prishanchit et al. 1984, 1985; Santoni et al. 1985, 1986).

1983-5: Prof. Anderson, from Brown University, excavated at Lang Rongrien Rockshelter at Krabi Province. The site is very famous in South-western Thailand. The radiocarbon dating is around 37,000 ± 1780 B.P (Late Pleistocene) and 7580 ± 70 B.P (Middle Holocene). Also, he published the report of Lang Rongrien's excavation (1983-1985) with Silpakorn University in 1986 (Anderson 1987, 1987b, 1988, 1990; Pookajorn 1994, 2001; Marwick 2007).

1985-6: Santoni M., Prishanchit and Pengtako excavated at Obluang sites found by French Archaeological Mission and Fine Arts Department of Thailand Project. The site is on the river of Mae Chaem in Chiang Mai province, and two areas on the left bank of the river were excavated. These sites generally corresponded to different periods. For example, the Mesolithic settlement under a rockshelter outstandingly yielded pebble tools of a general Hoabinhian type. Another settlement was found on the right bank, yielding assemblages of polished stone axes and adzes, cord mark pottery and a few pebble tools (Prishanchit et al. 1984, 1985; Santoni et al. 1985, 1986, 1990).

1986: Natapintu's team surveyed at Don Noi, Rai Nai Tawee and Ban Tai Wang, at Bo Ploi district, Kanchanaburi province. The prehistoric sites had predominantly flaked stones. Furthermore, in early1987, Natapintu, Broson, Charoenwongsa and staff from Silpakorn University also revisited again at Don Noi site, where they collected some stone assemblages, but this site was not excavated (Natapintu 1987, 1988, 1991; Charoenwongsa and Bronson 1988; Shoocongdej 1996).

1989-1996: Shoocongdej worked on the materials from Lang Kamnan, Kanchanaburi province - the quite oldest dated cave in western Thailand - for her Ph.D thesis at University of Michigan. The cultural sequences at Lang Kamnan were divided into three layers, apparently based on the radiocarbon dates, stratigraphy and archaeological remains. These layers corresponded to the late Pleistocene (c. 27, 000 - 10, 000 B.P), early Holocene (c.10, 000 - 7500 B.P) and the middle Holocene (c.7500 - 2500 B.P) (Shoocongdej 1990, 1996, 1996a, 1996b, 2000).

Figure 1.2.6 Photograph of Rasmi Shoocongdej (Thai archaeologist) (Source: https://www.google.fr/search?q=rasmi+shoocongdej)

1991: Pookajorn and staff from Silpakorn University, explored and excavated at Moh Khiew Rockshelter, at Ban Nha Shing, Krabi province, South-western Thailand. The site is a well- known burial place, which is largely comprehensive in archaeological remains like stone tools, fauna, micro fauna, flora, and sea shells from the Andaman Ocean. The radiocarbon dates range from 25,800 ± 600 B.P (Pleistocene) to 10, 500 ± 100 B.P, and 4240 ± 70 B.P (Holocene) (Pookajorn 1991, 1994, 2001; Chaimanee 1994; Auetrakulvit 1995; Thipkamjornwong 1997; Chitkament 2007).

1994: Auetrakulvit (former student of Pookajorn) excavated at Moh Khiew Rockshelter area 2, about 30 meters from area 1, in the context of his Master degree in Silpakorn University, Bangkok. Concurrently, Pookajorn excavated at Sakai cave, Trang province in 1994. In the same year, he also published a report of this excavation (Pookajorn 1994, 2001; Chaimanee 1994; Auetrakulvit 1995, 2004, 2006; Auetrakulvit et al. 2012).

2001-2: Shoocongdej and staff conducted the Highland Archaeology Project, in Pang Mapha district, Mae Hong Son province, north-western Thailand. The excavations were supported by Thai Research Fund (TRF) and Silpakorn University, Bangkok, Thailand. Two prehistoric sites-Tham Lod and Ban Rai Rockshelters were excavated.

According to Shoocongdej (2006), the Tham Lod Rockshelter provides late Pleistocene to Holocene occupations ca. 35,000 B.P. This shelter has yielded several burials, significantly associated with remains of fauna, shells, flakes and a used pebble tools (Khaokhiew 2003, 2004; Khaewkamput 2003; Pureepatpong 2004, 2006; Amphansri 2004, 2005; Kheawtaya 2005; Treekanchawattana & Pumijumnong 2005; Wattanpitasakul 2006).

On the other hand, the site at Ban Rai Rockshelter was excavated in three trenches. The archaeological materials were quite rich in the stone artefacts, animal bones, shellfish remains and a flexed burial, indicating the pre-Log coffin culture. This culture represented a stone-using period, when hunting and collecting formed the basis of the subsistence pattern (Treerayapiwat 1998, 2005; Shoocongdej 2003, 2004; Pureepatpong 2004, 2006).

Nowadays, the Highland Archaeology Project, at Mae Hong Son province, formally led by Dr. Rasmi Shoocongdej, is still continuing. During 2011, they also excavated a new prehistoric site (Muang Pang Hot Spring) at Pai district, Mae Hong Son province, North-western Thailand.

Dr. Zeitoun and Dr. Forestier etc., from Thai- French PaleoSurvey, Northern Archaeological Center, have discovered various prehistoric sites in Northern Thailand. Their goal was to discover new human settlements in Northern Thailand during early period. Significantly, they explored the site of Huai Hin, in Mae Sariang, which has prominently opened the field on the eastern bank of Salaween River. According to Forestier et al. 2006, around 181 pieces of Hoabinhian artefacts have been collected in two locations from this area. Besides, the Thai- French PaleoSurvey's team discovered more materials in the basaltic region of Lampang province, Northern Thailand. Also, they are working and publishing new artefact assemblages from Thailand (Forestier et al. 2006, 2013; Zeitoun et al. 2008, 2013).

Dr. Prasit Auetrakulvit (2010) re-excavated a new trench at Moh Khiew Rockshelter area 1, Krabi province, and new data of stone artefacts have been published in 2012 (Auetrakulvit et al. 2012).

Dr. Marwick (2011)'s team excavated the prehistoric site at Khao Toh Chang, Krabi province, South-western Thailand. The chronological sequence corresponded to late Pleistocene to Holocene, approximately dated 13,026 ± 45 to 149 ± 25 B.P, based on the radiocarbon dates (Marwick et al. 2013; Conrad et al. 2013; Van Vlack 2014). In addition, there are also some lecturers from Silpakorn University, Bangkok, Thailand like Asst. Prof. Chawalit Khaokhiew, who is working in a prehistoric Rockshelter at Chumphon province, Southern Thailand.

Overall, from last ten years, some foreign and native archaeologists have discovered many archaeological sites in several parts of Thailand, but only a few excavations were notably conducted for the prehistoric periods.

1.3 Summary of the Hoabinhian sites in Thailand

The Hoabinhian culture is now well known in the whole of Southeast Asia. The definition of Hoabinhian was set up by the First Congress of Prehistorians of the Far-East in 1932, in Hanoi, following the work of Madeleine Colani (French archaeologist), who excavated caves and rockshelters in Hoa Bin province, Northern Vietnam (Colani 1926, 1927a, 1927b, 1931; Ha Van Tan 1979, 1980; Pookajorn 1984, 1988; Reynolds 1990; Shoocongdej 1996).

In the first meeting of the congress, it was proposed to accept the following definition and to recommend its use: "*Hoabinhian is a culture composed of implements that are in general flaked, with varied types of somewhat primitive workmanship. It is characterized by tools often knapped on one face only, by hammerstones, implements of sub-triangular section, discs, short axes, and almond-shape artifacts, along with a variable number of bone tools*" (Praehistorica Asiae Orientalis, 1932: 11; Matthews, 1964, 1966, 1969; Pookajorn 1984, 1988; Shoocongdej 1996).

The same committee considered that the Hoabinhian comprised three periods:

1). Hoabinhian I, flaked implements only, rather large and crude.

2). Hoabinhian II, somewhat smaller implements of finer workmanship, associated with proto-neoliths.

3). Hoabinhian III, Smaller implements, flakes with secondary working with rare exceptions, no proto-neoliths (Matthews 1964: 1-2, 1969: 68; Pookajorn, 1984, 1988).

However, this classification was lacking concise definitions of types, and was rather difficult to link with the archaeological stratigraphy (Matthews 1964, 1969; Pookajorn 1988). Importantly the diagnostic tool types of the Hoabinhian such as "sumatralith" and "short-axe" were not defined at this meeting. Later, Vietnamese archaeologists fitfully re-excavated the Hoabinhian sites studied by M. Colani. They confirmed the stratigraphic validity of her three phases- proposed earlier (Ha Van Tan 1988; Pookajorn 1988).

The term "Hoabinhian" was first used by Madeleine Colani with reference to excavations that she made in Northern Vietnam during the late 1920, with reservations about the dating that she proposed. She initially suggested that the Hoabinhian was an upper Pleistocene culture and, thus, late Palaeolithic. Soon after the official definition, the status of "culture" for the Hoabinhian was questioned (Colani1926, 1927a, 1927b, 1931; Matthews 1964, 1969; Ha Van Tan 1980, 1988; Pookajorn 1988; Reynolds 1990; Shoocongdej 1996; Chitkament 2007).

Karl G. Heider (1953) used the term of "complex" in his article on pebble tool complex in Thailand, where he examined the artifacts found by Van Heekeren and Sarasin (Heider 1958: 63). He said that "*There is little basis for culture, despite the wide area over which it was found. Many tools covering on the ground surface, those with the flaking extending around the entire circumference of pebble tool, resemble Hoabinhian types, and a few of the flatter specimens could be called "Sumatraliths". On the other hand, most of them could fit into a lower Palaeolithic complex, but it is not impossible* *that they too are Mesolithic. On none of the specimens are there significant signs of wear due to post manufacture rolling. Neither the patina nor the degree of rolling suggests anything but a temporally homogenous complex*".

Besides, Gorman also used the term "*Hoabinhian complex*", in his article (1969), "*Hoabinhian: A pebble tool complex with early plant associations in Southeast Asia*". He remarked that the early inhabitants of Spirit cave, in Thailand, apparently utilized a typical Hoabinhian lithic assemblage. The data from this site appeared to support the earlier data, and evidenced an early agriculture stage before the use of cereals in Southeast Asia, just prior to 6,000 years B.C. Therefore, some quadrangular adzes, small slate knives and cord-marked potteries appeared as quite intrusive elements in the continuing local Hoabinhian expression (Gorman 1969, 1970, 1971b, 1972).

Clark (1978) explains the term "complex" as: a recurrent configuration of elements or entities within a large system of series; and "technocomplex": "*as a group of culture characterized by assemblages sharing a polythetic range but differing specific types of the same general families of artifact-types, shared as a widely diffused and interlinked response to common factors in environment, economy, and technology*".

In 1994, Vietnamese archaeologists presented Hoabinhian artefacts dating around 17,000 years at the Hanoi conference; at that time many scholars formally agreed with this matter (Ha Van Tan 1988; Pookajorn 1988, 1994; Moser 2001):

1). The concept of the Hoabinhian should be kept.

2). The best concept for "Hoabinhian" was an industry rather than a culture or technocomplex.

3). The chronology of the Hoabinhian industry ranges from "late-to-terminal Pleistocene to early-to-middle Holocene".

4). The term of Sumatralith should be retained.

5). The Hoabinhian industry should be referred to as a "cobble" rather that as "pebble" tool industry.

6). The Hoabinhian should not be referred to as a "Mesolithic" phenomenon.

Many Hoabinhian sites throughout Mainland and Island Southeast Asia have been described as having prehistoric Hoabinhian activity. The topography of Vietnam, Thailand, Sumatra, Cambodia, Laos and Myanmar has preserved Hoabinhian assemblages but the quality and quantity of descriptions vary according to the relative significance of the Hoabinhian components in these sites. According to Moser (2001), beyond these core regions, there are isolated inventories of stone artefacts displaying Hoabinhian features in Nepal, South China, Taiwan and, Australia. Hoabinhian tools have also been identified in the Siwaliks of north-western India (Gaillard et al. 2010b, 2011, 2012, 2016).

The assertive Hoabinhian culture occurrs in two main site forms: first, inland caves and rockshelters, and second, coastal middens (Gorman 1968, 1969, 1970). The exceptions to these forms are the river foreshore sites of Sichuan (in Southwestern China; Chang 1977; Cheng 1957, 1959) and the open air sites (possibly also river foreshores) at Kota Tampan, western Malaysia (Majid and Tjia 1988; Sieveking 1960; Walker and Sieveking 1962) and in the Kwae Noi valley, Thailand (Heider 1958, 1960; Pookajorn

1977, 1979; Barnes 1990; Shoocongdej 1990, 1996). In all of these exceptions, a true Hoabinhian attribution may be questioned for, as mentioned above, Hoabinhian tools, if not the Hoabinhian itself, continue to be in use until the Metal Age. Therefore, surface finds need not be Hoabinhian at all.

From Thailand, the typical Hoabinhian is well known in several regions: in northern Thailand, at Spirit cave (Gorman 1970, 1971b, 1972), Tham Phaa Chan (White and Gorman 1979, 2004; Bannanurag 1988), Banyan Valley cave (Reynolds 1992), Obluang (Prishanchit et al. 1984; Santoni et al. 1985, 1986), Ban Rai and Tham Lod Rockshelters (Shoocongdej 2001, 2002, 2003, 2004, 2005, 2006, 2007); in western Thailand, at Ongbah cave (SØrensen 1988), Ban Kao sites (Pookajorn 1977, 1979, 1984, 1987, 1988), and Lang Kamnan (Shoocongdej 1996, 1996a, 1996b, 2000); for the peninsular Thailand, at Tham Khao Khi Chan (Reynolds1989), Lang Rongrien Rockshelter (Anderson 1986, 1987, 1987b, 1988, 1990, 1997), and Moh Khiew Rockshelter (Pookajorn 1991, 1994, 2001; Auetrakulvit 1995, 2004; Thipkamjornwong 1997, Chitkament 2007; Auetrakulvit et al. 2012).

According to Anderson (1987), who was supported by Reynolds (1989), Moh Khiew Rockshelter (Pookajorn 1991, 1994, 2001) may not be “typical Hoabinhian”. In well-developed sequences the Hoabinhian overlies three late Upper Pleistocene stages whose assemblages appear to be flake-based and not related to cobble tool industries. The assemblages are rather small. Therefore further evidence is needed to confirm a non-cobble tool industrial stage before Hoabinhian in the Pleistocene of Thailand (Reynolds *in Press*).

To better know the Hoabinhian sites in Thailand is greatly important for foreign and native archaeologists. It can help young researchers to understand the previous works, including the exploration and excavation of cultural remains. The geology and the Quaternary deposits can explain the archaeological record and must be well understood in relation to the sites of these regions. This review will help to establish the technical evolutionary trends and relationship between all techniques, used at that time in these sites. Therefore, my attempt is to summarize the important prehistoric sites, apparently related with the Hoabinhian that have been excavated in Thailand. It starts from the older dates in the late Pleistocene and extends to the Holocene period.

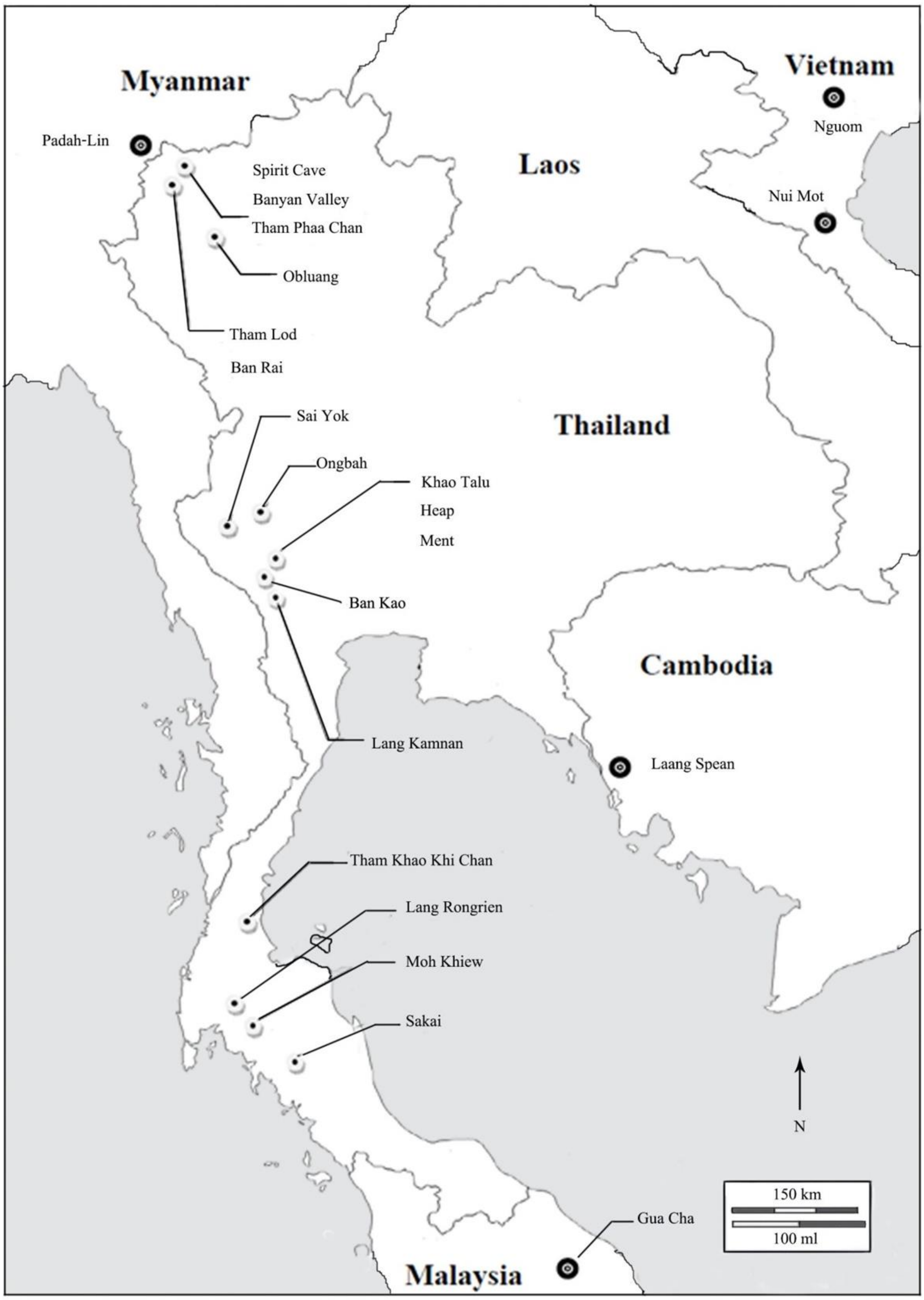


Figure 1.3.1 Map of Southeast Asia showing Thailand is related to various Hoabinhian sites

1.3.1 Lang Rongrien Rockshelter

Lang Rongrien Rockshelter is a stratified archaeological site, located in the Krabi River Valley, Krabi province, South-western Thailand. The site is very close (less than 12 km) to Moh Khiew Rockshelter. The Lang Rongrien Rockshelter has been excavated by Anderson from Brown University during 1983 to 1985. The aim of his excavation was to "trace the archaeological, biological and geological history of southwestern Thailand, or more broadly speaking, the northwestern most edge of the Sunda Shelf" (Anderson 1986, 1987, 1987b, 1988, 1990). Several hundreds of stone artefacts, potteries and organic objects were found from the shelter. Approximately 835 stone artefacts were recovered from Lang Rongrien Rockshelter.

Anderson (1990) has divided the archaeological remains from Lang Rongrien into three different cultural periods. These belong to the Southeast Asian Paleolithic. The first one is a final Palaeolithic belonging to the Late Pleistocene period; the second properly corresponds to the Hoabinhian culture in the early Holocene period; and the last one, the early pottery period, dated between 6,000 and 3,500 years ago.

Interestingly, the classification system of stone artefacts is typologically derived from van Heekeren's work at Sai Yok. It is based on artefacts' shapes, sizes and presumed functions (Anderson 1990: 38; Marwick 2007: 70). Although some comments are clearly made about retouch and inspection of artefact use-edges by low power magnification, there are no data in the publications. According to Marwick (2007, 2008), the metric and technological variables don't appear to have been part of Anderson's stone artefact analysis. The archaeological materials from Lang Rongrien Rockshelter had been displayed as following:

Stratigraphic units	**Characteristic of the archaeological materials**
Upper levels, (Units 1-4)	- A lot of stone artefacts, potteries, bones and shells were largely exposed in these units, including at least 4 burials, several hearth areas and pits. - One stone adze or axe blade was associated with the burial 4. - Hundred flaked shales or shale implements have been located in these deposits. - The forms of the implements were identical with those from units 5 and 6, readily notified as Hoabinhian. - The chipped off stone tools (rhomboid shaped) were made from waterworn boulders. - Other implements have been located in the upper level deposits, including a shell bracelet and half dozen antler artefacts.
Middle levels, (Units 5-6)	- The artefacts from stratigraphic units 5 and 6 were characterized by a predominance of relatively thin well-shaped, bifacially flaked tools. Most of the tools were commonly made from Carboniferous shale. - The numerically predominant tools were discoids, bifacially retouched, elongate knife blades, semi-lunar choppers and utilized flakes. - Twenty one of the 206 artefacts from stratigraphic units 5 and 6 were core tools, including 3 scrapers, 9 hammerstones and grindstones. - The flakes from these units were quite short and usually lacked the straight margins and arrises that normally characterize blades.

	- The pottery was absolutely absent in these units, excepted for one sherd in the uppermost layer of unit 5. - A wide variety of mammalian bones, freshwater and marine shellfishes were also recovered from these levels.
Middle level, (Unit 7)	- Only one anthropic feature occurred in this unit: a charcoal surrounded by broken bits of fossilized bone. Globally it is a non-cultural layer. - The only five stone artefacts were flake fragments and two unutilized flakes with faceted platform preparation. They were quite similar to those of units 8 through 10.
Lower levels, (Units 8-10)	- All three of the lower stratigraphic units have been interpreted as former living floors, with bones and artefacts. - The radiocarbon date of unit 8 is between 27,000 and 33,000 years B.P. From units 9 and 10 the date is around 38,000 B.P. - Forty five stone artefacts have been found in these units, including 2 bones, and 1 antler. Most of the lithic material is in chert. - Choppers are largely angular core tools with steep cutting edges shaped by unifacial flaking from a flat surface. The flake scars are also large and irregular, but the resultant edges are rather straight and sharp. - Core bifaces are frequently angular core tools with bifacially flaked cutting edges. These technologies are still called after the implements described by Movius as chopping tools, but these are flatter. - The retouched flakes have one or more unifacially flaked edges. The flake scars are quite short and steep.

The Pleistocene archeological assemblages are mostly small, unifacially retouched flake tools. The early Holocene assemblage differs because it is rather dominated by large, heavy, unifacially and bifacially flaked core tools, typical of the Hoabinhian industry (Marwick 2007, 2008). The Middle Holocene deposits include four burials with pedestal pots and small cord-marked vessels (Anderson 1986, 1987, 1990). According to Marwick (2008), the most unique and important result of this work is the suggestion that Southeast Asian Late Pleistocene assemblages may be flake industries rather than cobble-based industries as initially suggested by Movius (1948, 1969).

Anderson’s work is important because Lang Rongrien Rockshelter has a long culture sequence. His interpretation of the material is an unusually detailed engagement with historically and anthropologically significant themes in Southeast Asian archaeology (Marwick 2007, 2008). He compares the artefact types in Pleistocene layers of Lang Rongrien to other Pleistocene assemblages in Vietnam, Malaysia, Philippines, South Sulawasi and southern China. Also, he notes a series of differences, but emphasizes that all assemblages are characterized by flake tool assemblages with high proportions of amorphous flakes with steep unifacial retouch, and very low proportions of cobble artifacts (Anderson 1990: 66; Marwick 2007, 2008). Furthermore, Anderson (1990) interprets this regional pattern of Pleistocene flake assemblages as evidence of Movius’ Chopper-Chopping Tool Complex. It is not an accurate label for Southeast Asia assemblages because cobble chopping artefacts are not common, and the label emphasizes wide-area homogeneity and cultural conservatism that is contradicted by the available evidence. He also suggests an ecological explanation for the change of Hoabinhian origins at Lang Rongrien. The Pleistocene flake assemblages to Holocene cobble assemblages are a response to reduced seasonality, increased precipitation and warmer temperatures during Holocene (Anderson 1990, 1997).

Therefore, it is problematic that his conclusions about the Pleistocene flake industry are based on only 58 artefacts (Pleistocene assemblages), which may be the result of some series of isolated short episodes rather than reflecting a long term pattern (Bulbeck 2003; Marwick 2007, 2008). The most important problems with his work, like those before him, are the absence of detailed stone artefact data and the failure to acknowledge contemporary developments in hunter-gather anthropology and archeology.

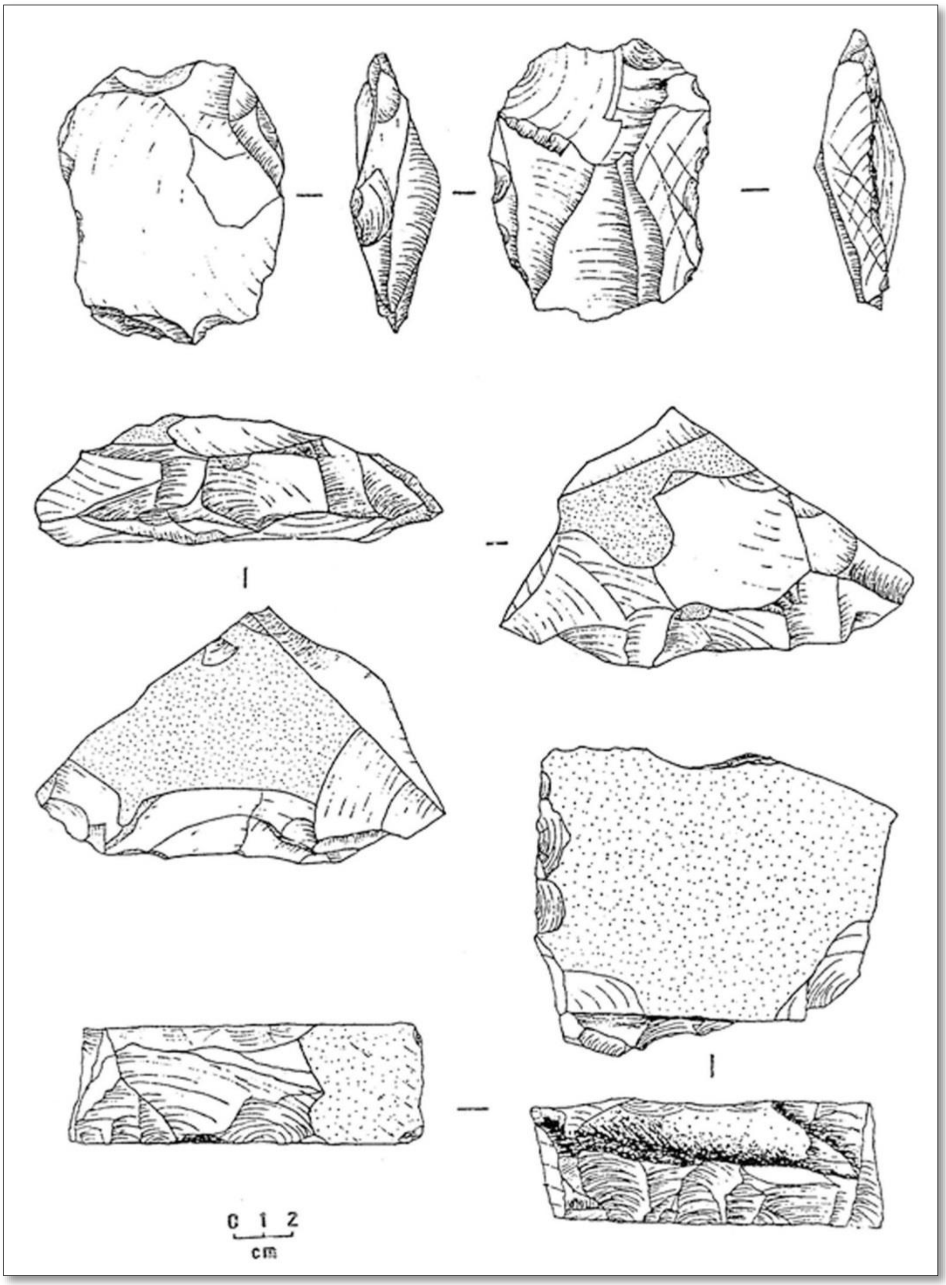


Figure 1.3.2 Stone artefacts from Lang Rongrien Rockshelter, South-western Thailand (Source: Anderson 1990)

Lab No.	**Stratigraphic Unit**	**Field number, description and location of samples**	**Comments**	**Date B.P. 5568 half life**	**Date B.P. 5730 half life**
SI-6212A	2B	#48, charcoal, s-0.70 to 1.00; E.-2.00 to 2.05; Depth 70 cm.	Mixed stratum	7580 ± 700 B.P	7807
SI-6212B	2B	#50, charcoal, pit #1, NE quadrant; Depth 70 cm.	Mixed stratum	8430 ± 70 B.P	8683
SI-6213	5 upper	#202, charcoal, s-1.40 to 1.55; E. 1.25 to 1.40; depth 162-166 cm.		7765 ± 65 B.P	7999
SI-6814	5 lower	#201, charcoal, s-1.25 to 1.42; E. 2.00 to 2.36; depth 180-188 cm.		7575 ± 75 B.P	7802
SI-6217	5 or 6	#583, charcoal, s-0.76 to 0.80; E. 3.30 to 3.90; depth 192-194 cm.		9655 ± 90 B.P	9945
SI-6215A	6	#339, charcoal, s-1.95 to 1.55; E. 0.50 to 0.70; depth 190-200 cm.		7655 ± 70 B.P	7885
SI-6215B	6	#340, charcoal, s-1.20 to 1.30; E. 1.20 to 1.40; depth 180-183 cm.		8300 ± 85 B.P	8549
SI-6216	7	#358, charcoal, s-4.00 to 5.00; E. 1.00 to 1.20; depth 209-210 cm.	From roof fall	>43,000	>44,000
SI-6217	8	#44 and 45, charcoal, s-3.81 to 3.88; E. 3.70 to 3.90; Depth 273-279 cm, and s-4.10 to 4.40; E-5.15 to 5.40; depth 284-286 cm.		27,350 ± 570 B.P	28,171
SI-6816	8	#585, charcoal, s-4.90 to 5.75; E. 2.00 to 2.20; depth 235-243 cm.		27,110 ± 615 B.P	27,923
SI-6818	8	#756 and 757, charcoal, s-7.45 to 7.60; E. 7.10 to 7.30; depth 308 cm.		32,180 ± 1300 B.P	33,145
SI-6819	9	#608, charcoal, s-4.90 to 5.50; E. 0.60 to 1.20; depth 270 cm.		37,000 ± 1780 B.P	38,11

Table 1.3.1 Radiocarbon dates from Lang Rongrien Rockshelter, Krabi Province, South-western Thailand (Source: Anderson 1990: 21

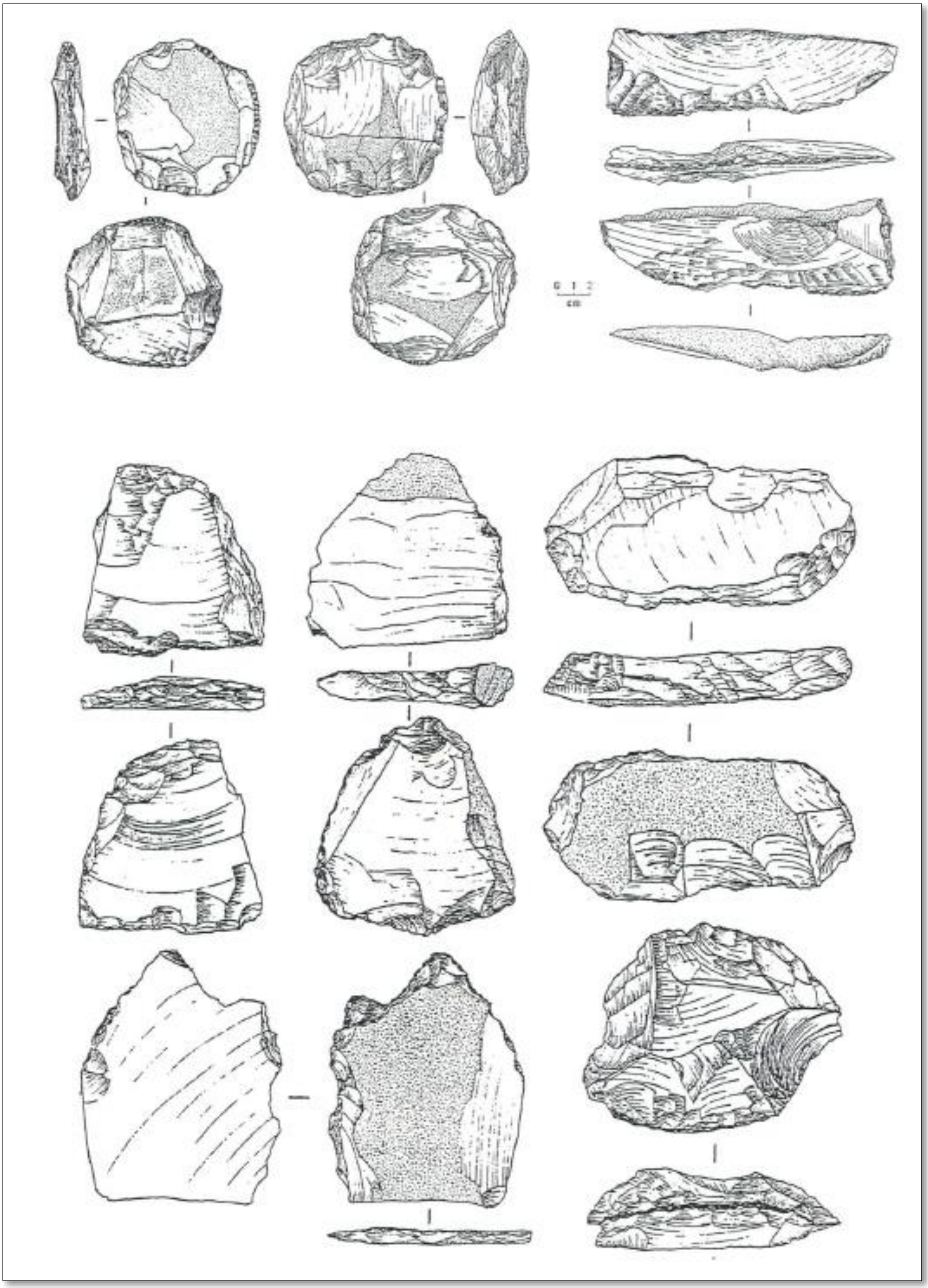


Figure 1.3.3 Stone artefacts from Lang Rongrien Rockshelter, South-western Thailand (Source: Anderson 1990)

1.3.2 Obluang

The sites at Obluang are located on the Mae Chaem River, about 17 km northwest of the Hot district, province of Chiang Mai, Northern Thailand. The sites were formally discovered in 1984 by Prishanchit S. and Pengtaka P. of the Northern Thailand Archaeological Research Project. They collected the artefacts from the surface such as cord-marked sherds, stone tools and flakes. The results of the survey were entirely reported to the Fine Arts Department of Thailand (Prishanchit and Pengtako 1984; Santoni et al. 1985, 1986, 1990). The archaeological remnants of the occupation were partially spread on the slopes of the hills that border the Mae Chaem River (a tributary of the Ping River). In this area, the river flows in a deep and narrow gorge, which gives its name to the site (Ob-luang = Great Gorge).

The Obluang sites were excavated from 1985 to 1986 by the Thai-French Prehistoric Research Project. Two areas on the left bank of the river have been excavated and these corresponded to two different periods (Hoabinhian and Bronze Age). On the right bank, the traces of a possible Neolithic settlement were also explored (Santoni et al.1985, 1986, 1990)

Tham Pha Chang Rockshelter is one of these two sites located on the left bank of the Mae Chaem River. The Hoabinhian settlement is situated under the Pha Chang Rockshelter (Elephant shelter), which is formed by a inclined, huge block of rock (migmatitic gneiss) laid on the slope of the hill, and on subterranean blocks, its base being partially exposed. The wall of shelter contains two series of painting. The more recent ones (white pigment) represent several figurative motifs, including elephant, unidentified animals and human shapes (Prishanchit and Pengtako 1984; Santoni et al. 1985, 1986, 1990). These motives overlap more ancient paintings (red pigment) erased and no long recognizable, probably contemporaneous with the prehistoric occupation of the shelter.

The archaeological materials have been exposed from the undisturbed layers (from the test area) and the disturbed areas (sinkhole included) which were quite homogenous. The undisturbed deposits could be divided into five layers, and three occupational floors might be recognized from the excavation (Santoni et al. 1985, 1986, 1990). The materials belonging to the various phases of occupation were apparently transported down by water, and mixed in the disturbed area. Besides, large stone implements and several bone fragments were found from the Hoabinhian levels, which are probably of the same age. A few fragments of polished objects and some cord-marked wares tended to prove the existence of a small Neolithic occupation. It might have lasted a short time period because no trace has been preserved in the undisturbed layers (Santoni et al. 1986, 1990).

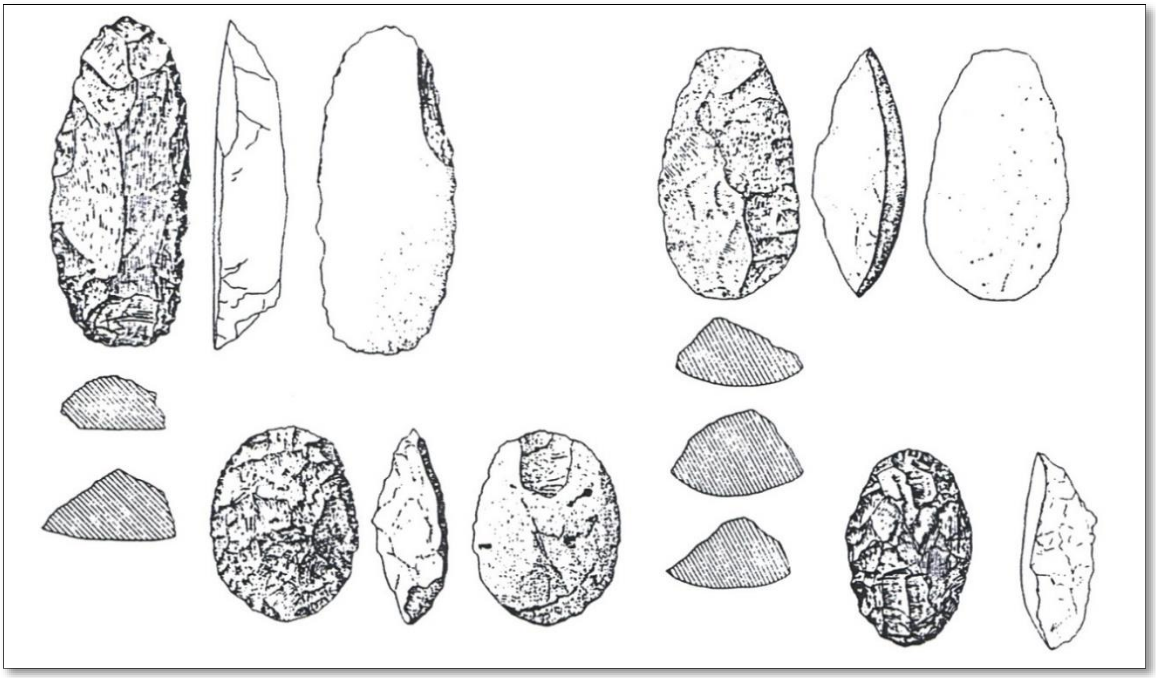
The stone materials are mainly in quartzite: complete or mostly broken pebbles, core tools, flake tools and waste flakes. Remarkable is the presence of a few flaked rock crystals and other siliceous rocks. All the raw material had been brought to the shelter and was exogenous, but the flaking was rather carried out under shelter (Santoni et al. 1986, 1990). A large number of snail shells were also found, some of them in good condition, other almost disintegrated or broken into small pieces. Several fragments of haematite, which had been used, were retrieved from the deepest layer.

According to Santoni et al. (1990), the technological study of the stone assemblages was only roughed in the classification of the artefacts, since all the materials could not be examined and counted during the field season. Therefore, any percentage hasn't been given for the tool types. The average size of the tools was less than the average size of the pebbles from the bank, suggesting that the prehistoric tool makers used to select the size of materials. There was no evidence that these materials were specially sought for making a certain type of tool. Most of the core tools were unifacially flaked, which have seldom covered the whole face of the pebble. The characteristic of lithic materials could be explored in Tham Pha Chang as follows:

Stone artefacts	**Characteristic of the lithic assemblages**
Flakes	- All phases of flaking were abundantly represented under the shelter. - Large flakes and short laminar flakes were more in number than lamellar flakes (blades or bladelets), very rare in the deposit. - Many flake fragments and pebbles had also been exposed, as well as complete unflaked pebbles. The size of the artefacts was a variable and the small and middle sized pebbles were mostly frequent.
Axe/adzes	- These axes/adzes, probably multifunctional, were unifacial and could be roughly divided into types. 1). First type: tools with a curvilinear cutting edge presented a silhouette similar to that of certain bifacial tools, in the middle Palaeolithic of Europe. 2). Second type: tools with a rectilinear cutting edge that reminded the shape of Neolithic axes. Some intermediate morphologies, and unfinished tools also occurred, all of them making any classification difficult. - These objects usually had a cutting edge and margin, seemingly used. The broken pieces might be mistaken for certain thick scrapers. - On the site of Obluang lance-shaped, oval-shaped, or discoid morphologies (sumatralith type) were more in number than the real axe types. - No true "short axe" had been found, though the shortest tools might be close to this type.
Scrapers, cutters or cleavers	- These tools constituted the largest artefacts group in the whole deposit and could be divided into two categories between side scraper and end scraper. 1). First category (side scrapers): including the different instruments, from the thick scraper to some pieces with a flat silhouette. - Some double instruments with two functional edges were morphologically related to the axe type. - The margins of the dorsal face rather seemed to have a similar function. Most of the scars were those of the cutters or cleavers, as much as of true scrapers. Their typologies were very close. - The cutting edges were mostly slightly bowed, besides discoidal scrapers and scraper with points. 2). Second category (end scrapers): including thin choppers, double end-scrapers on long pebbles, and some small tools with a rounded front, on flat pebbles. Some side- and end scrapers had also been exposed. 3). The multiple scrapers, were made on very flat pebbles (with totally flaked margins) or on flakes. All of them were quite original and could constitute a third category. - Some large tools, with flakes only removed from the margin (similar to multiple scrapers) might be added to this group.

Assemblages of grinder/ crushers, hammers and polishers	- These tools are abundant in recent prehistoric sites. Here, most of them rather occur in very small numbers. - Their characteristics were a few traces of percussion and sometimes they had been definitely polished on middle-sized pebbles.
Perforated tools	- Only three pieces like a perforated pebble, fragments of a flat ring, and half of a flat oval pebble with opposing pits (perhaps an unfinished perforation) had been recovered.
Broken tools and pebbles	- A large number of broken flaked pebbles had been exposed. Most of them did not form a separate group, but their identification was sometime difficult. They were parts of broken tools or the result of accidents during the flaking process, which was difficult to determine. - Some of these unfinished tools had been used as such, and broken tools might have been re-used.
Flake tools	- These were proportionally less in numbers than core tools. Most of flake tools had been retouched flakes, and made from flint or chert. - Side and end scrapers were frequently found, besides a few points, notched pieces and denticulates.

In summary, the stone assemblages at Tham Pha Chang Rockshelter seemed rather homogenous. No real technological and morphological evolution of the stone tools could be traced through the examination of material from undisturbed layers. They did not differ from the more abundant materials, recovered from the sinkhole and test pit. Consequently, the occupation did not cover a very large area, but it might be quite long. Only one culture period had ultimately been dated of 28,000 B.P on the fragment of burned bones (Santoni et al. 1986, 1990). No information could be worked out regarding the type of the occupation, because any real habitation structure hadn’t been found. Only, it was a true settlement, perhaps used as a seasonal camp site and often used, but during short period (Santoni et al. 1986, 1990).



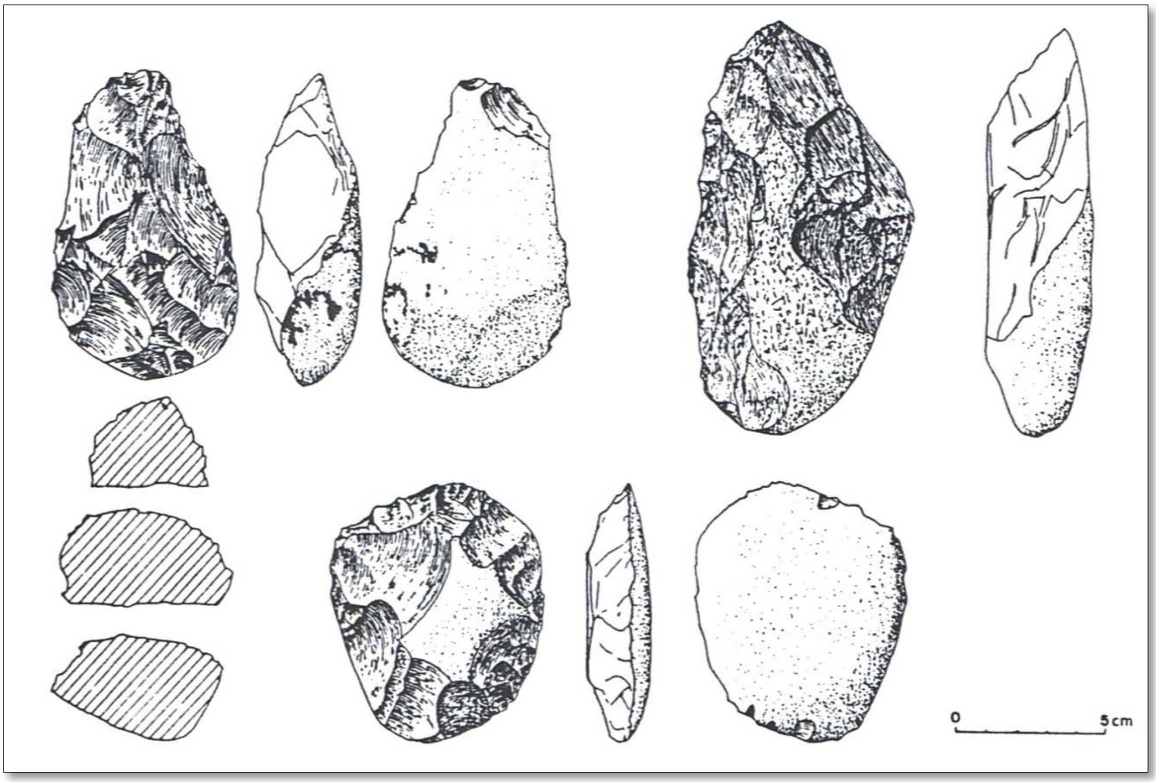


Figure 1.3.4 Stone artefacts from Tham Pha Chang Rockshelter, Obluang, Northern Thailand (Source: Santoni et al.1990)

1.3.3 Moh Khiew Rockshelter

Moh Khiew Rockshelter is located at Ban Nha-Shing, Thambon Krabi Noi, Muang district, Krabi province, South-western Thailand. The site is a well-known burial place. Significantly, it is very rich in archaeological remains, including artefacts, fauna, micro fauna, flora and also sea shells from Andaman Ocean. Moh Khiew Rockshelter is situated on the isolated hill (Permian limestone) of Krabi province. In 1991, Prof. Surin Pookajorn and staff from Silpakorn University explored and excavated at Moh Khiew Rockshelter area 1. Later, in 1994, Auetrakulvit (former student of Pookajorn) excavated the Moh Khiew Rockshelter area 2, in the same rockshelter, and about 30 meters from area 1. A total of 20,454 artefacts from Moh Khiew area 1 were identified by Pookajorn and staff from Silpakorn University. Out of these, there were 280 core tools, 12,595 flakes and 7,579 flake fragments (Pookajorn 1991, 1994, 2001; Chaimanee 1994; Auetrakulvit 1995; Thipkamjornwong 1997), from different layers as follows:

Stratigraphic layers	Characteristic of the archaeological materials
layer 1	- Polished adzes, blank axes and some flake fragments were moderately displayed in the upper level of this layer. - Bone tools, like pointed end tools, were associated with other kinds of stone artefacts and potsherds. - Faunal remains like animal bones and shells, and floral remains also occurred. - The fire pits were rather scattered in this layer, associated with animal bones, plant seeds and stone artefacts.
layer 2	- Unifacial tools and bifacial axes frequently made of cherts. A few blank axes were quite similar to those of layer 1. - Flake tools, including some used ones. - Bone tools like pointed end bones. Some antlers markedly indicated using traces. More faunal and floral remains than in the layer 1were exposed. - Fire pits, related to charcoal, fired bones, fired seeds and stone artefacts. All the potsherds, not different from layer 1.
Layer 3	- Stone tools are generally similar in shape to the Hoabinhian tools. - Most of raw materials were chert and quartzite. The stone artefacts belonged to different types, but were quite similar in shape. - Flake tools like concave scraper and arrowhead, were represented. Bone tools like pointed tools, were made from the big-sized animal bones and antler. - The variety of animal bones, marine shellfishes and ornaments were generally yielded by this layer. - The human skeletons no. 2, 3 and 4 had outstandingly been exposed by the extended excavation, after the burial 1 was found in layer 4.
Layer 4	- Most of unifacial and bifacial tools, made of chert, have been heavily utilized. - Flake tools and bone tools were partially present in this layer, including deer horns, used as hammers. - Many features of fire pits were associated with fired bones, seeds and stone artefacts. The human skeleton no.1 was discovered at the boundary between layers 4 and 5.

Layer 5	- Stone artefacts such as unifacial and bifacial tools, largely represented in upper levels. - Unifacial tools have quite bigger sizes, but are technically less elaborated. - The characteristic of unifacial and bifacial tools is made by direct percussion with hard hammer stone technique. - Some unifacial pebble tools are quite similar to those excavated from Kota Tampan, in Perak, state of Malaysia. - Large-sized faunal remains, including scapular bones, which belonged to the big water buffalo. Vegetal remains like fired seeds were rarely found. - The fire pit was commonly associated with charcoal, ash, stone tools and fired bones.

In terms of reference for feasibility study, in 2007, I conducted my Master dissertation on *Lithic analysis of Moh Khiew Rockshelter "Locality 1" in Krabi river valley, Krabi province, Southwestern- Thailand*. I could not interpret more about Hoabinhian culture at Moh Khiew Rockshelter since the majority of materials from each archaeological unit were not available from collections at Silpakorn University, Bangkok.

I carefully studied only 713 artefacts in this work, while 20,454 artefacts had been recovered from the excavation. No conclusive interpretation could be made on typology of Hoabinhian culture in South-western Thailand. However, from the observation of the lithic assemblage typology, my conclusion was that the lithic industry from Moh Khiew Rockshelter "locality 1" might be local Hoabinhian. It was characterized by bifacial adzes rather than the typical unifacial ones, known as "sumatraliths". This specificity may be related to the raw materials especially the silicified shale (Chitkament 2007).

According to Anderson (1987), who was supported by Reynolds (1989), Moh Khiew Rockshelter might not be "typical Hoabinhian." However, Moser (2001), who had precisely studied 2 Hoabinhian collections at Moh Khiew and Xom Trai in Vietnam, thought differently. My results are not in disagreement with these authors.

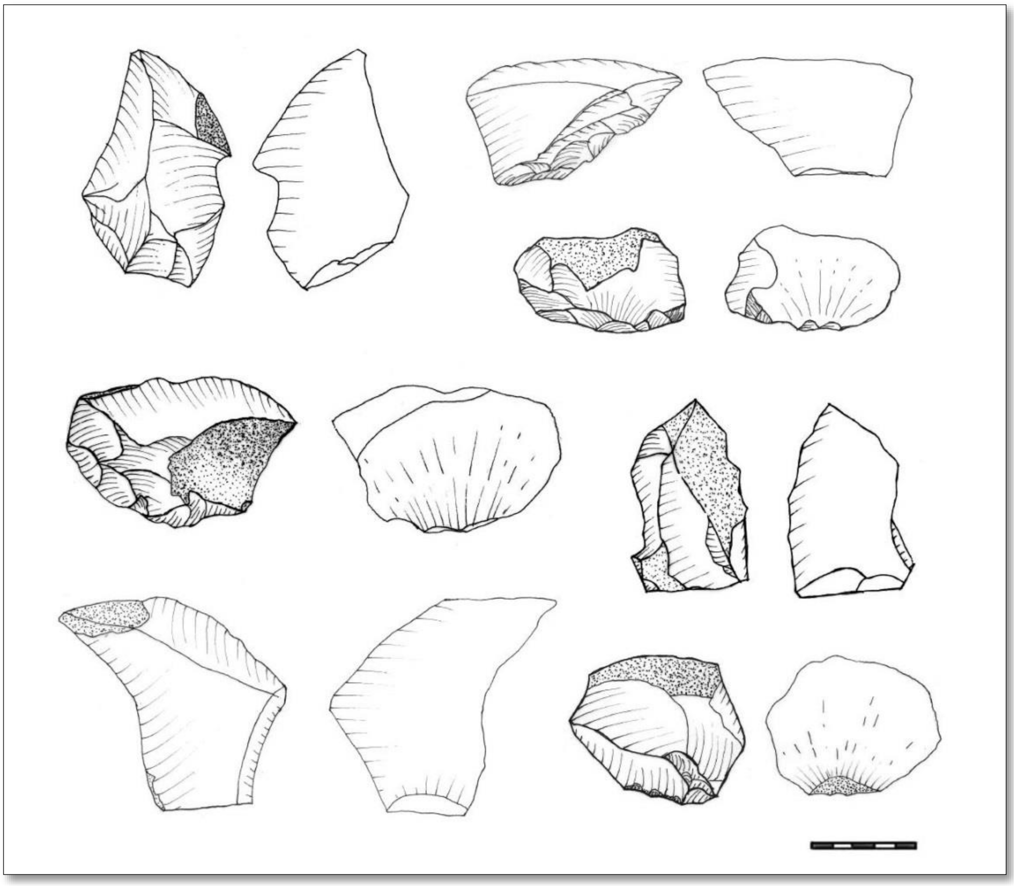


Figure 1.3.5 Elongated and short flakes from Moh Khiew Rockshelter, locality 1, South-western Thailand (Source: Chitkament 2007)

Stratigraphic layers	**Cultural Period**	**Radiocarbon Ages**	**Geological Period**
Layer 1 (75- 45 cm)	Late Neolithic (Adze + Pottery)	4,240 ± 150 B.P	Middle Holocene
Layer 2 (170-80 cm)	Early Neolithic (Blank axe)	7,160 - 5,520 B.P	Middle Holocene
Layer 3(295-175 cm)	Pre-Neolithic (Pebble + Flake tools)	11,170 - 8,330 B.P	Early Holocene
Layer 4 (385-300 cm)	Late Palaeolithic (Flake tolos)	25,000 ± 600 B.P	Late Pleistocene
Layer 5(390 -400 up cm)	Late Palaeolithic (Flake tools)	25,800 ± 600 B.P	Late Pleistocene

Table 1.3.2 Radiocarbon dating results from Moh Khiew Rockshelter, South-western Thailand (Source: Pookajorn 2001)

Lab No.	Sample No.	Sample description	Radiocarbon Ages	Date B.P 5568 half life	Cultural Level
OAEP-1290	391	Zone 5; 65-70 cm.dt., natural soil layer 2a	4240 ± 150 B.P	4090 - 4390 B.P	5
OAEP-1289	366	Zone 5; 75-80 cm.dt, natural soil layer 2	5940 ± 140 B.P	5800 - 6080 B.P	4
OAEP-1291	477	Zone 2; 100-105 cm.dt, natural soil layer 2	5590 ± 70 B.P	5520 - 5660 B.P	4
OAEP-1277	529	Zone 5; 110-115 cm.dt, natural soil layer 3a	7060 ± 100 B.P	6950 - 7160 B.P	4
OAEP-1278	542	Zone 4; 110-115 cm.dt, natural soil layer 3a	6090 ± 150 B.P	5940 - 6240 B.P	4
OAEP-1279	756	Zone 4; 130-135 cm.dt, natural soil layer 3	9775 ± 100 B.P	9670 - 9870 B.P	3
OAEP-1292	733	Zone 1; 135-140 cm.dt, natural soil Layer 3	8420 ± 90 B.P	8330 - 8510 B.P	3
OAEP-1280	905	Zone 4; 150-155 cm.dt, natural soil layer 3	9670 ± 100 B.P	9570 - 9770 B.P	3
OAEP-1281	948	Zone 3; 160-165 cm.dt, natural soil layer 4	10,470 ± 80 B.P	10,390 - 10,550 B.P	3
OAEP-1284	1072	Zone 1; 180-185 cm.dt, natural soil layer 4	11,020 ± 150 B.P	10,870 - 11,070 B.P	3
OAEP-1283	1115	Zone 2; 185-190 cm.dt, natural soil layer 4	102,530 ± 100 B.P	10,430 - 10,630 B.P	3
TK-933 Pr	-	Zone 2; 395-400 cm.dt, natural soil layer 5	25,800 ± 600 B.P	25,200 - 26,400 B.P	1

*OAEP = Office of Atomic Energy of peace of Thailand, *TK= Tokyo University Laboratory (Japan)., based on half-life of 5568 years

+ Radiocarbon determination based on half-life of 5568 years

Table 1.3.3 Radiocarbon dates of charcoal samples from Moh Khiew Rockshelter, South-western Thailand (Source: Pookajorn 1994)

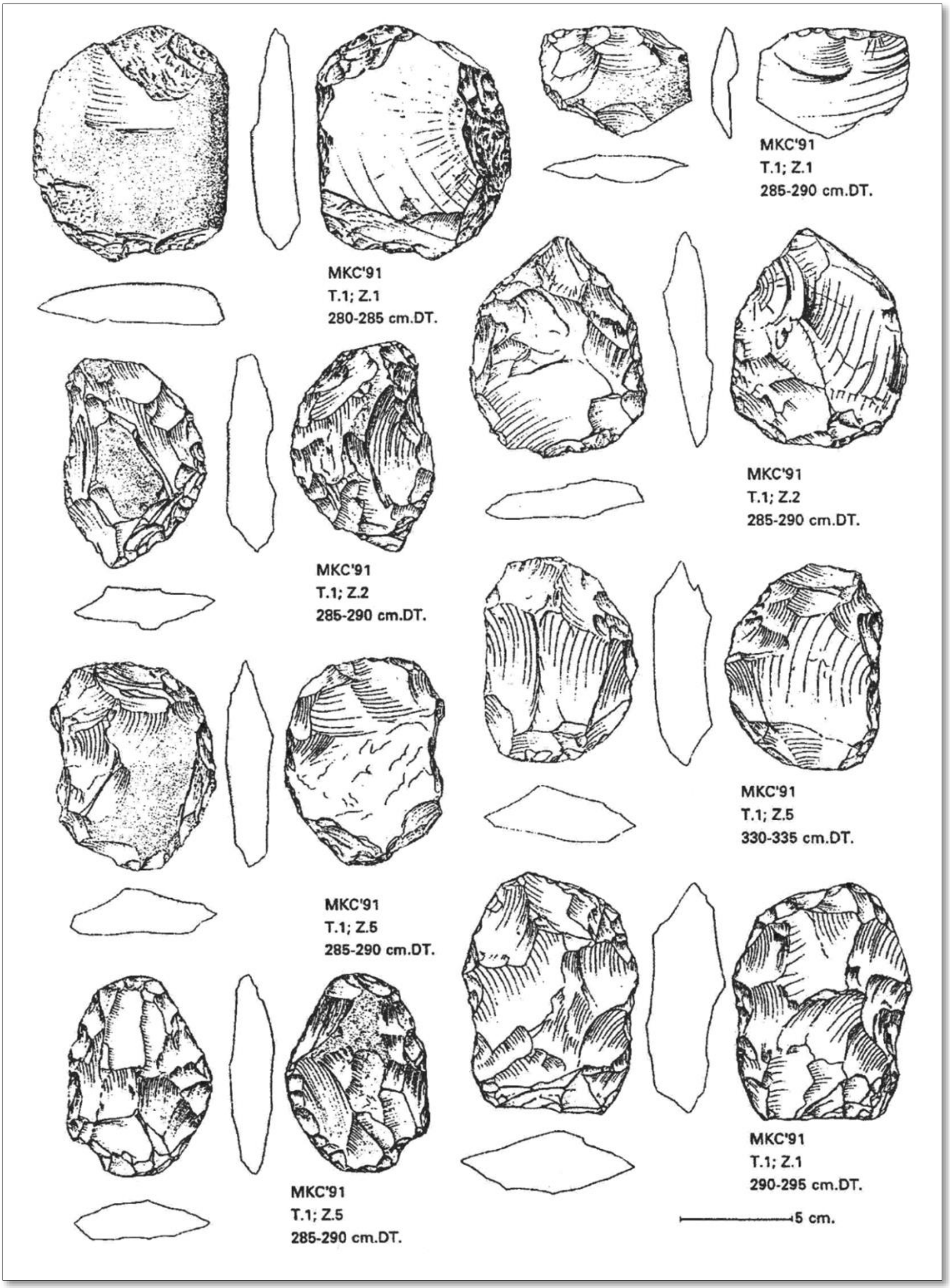


Figure 1.3.6 Stone artefacts from Moh Khiew Rockshelter, South-western Thailand (Source: Pookajorn 1994)

1.3.4 Lang Kamnan Cave

Lang Kamnan cave is located in Kanchanaburi province, western Thailand. The first cave was recovered by the local villagers of Ban Tung Nagarat, who searched guano. In 1989, Shoocongdej was doing a field season at Kanchanaburi province. A villager teacher informed her about the site of Lang Kamnan cave. In 1990, she returned to conduct the excavation for her Ph.D research at University of Michigan.

The stratigraphy of this site yielded a variety of lithic assemblages, faunal, floral and shellfish remains. Basic artefact classification was carried out in the field following the system used by Shoocongdej (1996, 1996a, 1996b, 2000). Counts and weights for lithic, postsherds and bones were recorded for each provenience and excavation unit. Besides, she also classified stone artefacts on the basis of characteristics related to manufacture, use, maintenance and discard. The proportions of these groups of artefacts were compared to understand the archaeological record found at Lang Kamnan cave (Shoocongdej 1996, 1996a, 1996b, 2000).

A total of 874 artefacts were collected into five stratigraphic layers (Shoocongdej 1996). In order to build a culture chronology of Lang Kamnan site, Shoocongdej carefully correlated observations between the three excavation's sectors, N3E2, N2E4 and N4E4 as following:

Stratigraphic layers	**Characteristic of the archaeological materials**
Layer 1	- The sectors N3E2 and N4E4 had been affected by recent human's disturbance. All the sectors were completely destroyed by guano digging. - Archaeological materials from sectors N3E2 and N4E4 contained earthen ware sherds, animal bones, flakes and shellfishes. - Stone artefacts were only comprised of the flake fragments.
Layer 2	- Lithic artefacts, animal bones and shell fishes had been recovered in all sectors of excavation. - The stone artefacts were markedly comprised of flake fragments, flakes, core tools, resharpening flakes, hammers, fragments and pebbles & cobbles. - More core tools, big fragments and pebbles & cobbles were exposed in larger quantity than in other layers. - Freshwater shells were commonly displayed in sectors N2E4 and N4E4. - From upper part of this layer had been recovered a number of earthenware sherds. - Among the three sectors, the sector N4E4 contained the highest number of archaeological assemblages, including some faunal and floral remains.

Layer 3	- Stone artefacts were still dominated by flake fragments. Significantly, core tools, flakes and hammerstones were also found in this layer, besides animal bones and landsnail shells. - The archaeological assemblages, including mollusc remains, slightly increased in the sectors N2E4 and N4E4. - A lot of stone artefacts had been recovered in sector N3E2, but less animal bones and mollusc remains. Only three seeds were evidently notified from the entire site and most of them had been exposed in sectors N3E2, N4E4 and N5W1.
Layer 4	- The sectors N2E4 and N4E4 evidenced the human occupation in the cave. This layer yielded assemblages of small flakes, core tools and fragments, as well as animal bones, shells of land and freshwater snails, especially in sectors N2E4 and N4E4 - Lithic artefacts were dominated by flake fragments, besides a few utilized flakes and core tools. - The sector N4E4 was greatly determined by the highest quantity of archaeological remains, especially by a large middle deposit of the landsnail shells (*Cyclophorus sp*.)
Layer 5	- No stone artefacts in this layer. Some animal bones and shell remains had occasionally been discovered in sectors N2E4 and N4E4. - The archaeological remains from this lower layer might be reworked from the upper layers due to disturbances by humans and animals. In this stratigraphic layer no cultural occupation was identified.

Shoocongdej (1996) had recognized three cultural phases at Lang Kamnan cave, primarily defined on the basis of the radiometric dates and the appearance of ceramics.

Component I: from ca. 30,000 to 10,000 B.P in late Pleistocene and early Holocene periods; these are the earliest dates for western Thailand. Based on radiometric dates this is compared with the oldest occupation of Ongbah cave, the “Hoabinhian period” (SØrensen 1988; Shoocongdej 1996, 2000).

Component II: properly covered from ca. 10,000 to 7500 B.P in early Holocene. The radiocarbon dating were realized for several sites of this region. The evidence has been suggested that in this component was similarly compared with the “early Hoabinhian period” from Khao Talu, Heap and Ongbah caves in the “Hoabinhian period” (Pookajorn 1977, 1979, 1984; SØrensen 1988; Shoocongdej 1996, 2000).

Component III: occured from ca. 7500 to 2500 B.P in middle Holocene. This component is characterised by people who used ceramics. The stratigraphic layer 1 was overwhelmingly represented in the late period, and it could be placed in the middle Holocene (Shoocongdej 1996, 2000). This component can be compared with the Ban Kao site (SØrensen and Hatting 1967; You-Di 1986, SØrensen 1988; Shoocongdej 1996, 2000) and Khao Talu cave (Pookajorn 1977, 1979, 1984), sharing similar artefact types and black burnished pottery.

Sample No.	Unit	Cultural layer	Material and Context	Sediment	Conventional Age B.P (±1 s.d.)	Calibrated age Range B.P (±2 s.d.)	Lab No.	Remarks
1	N3 E2	III	Carbonized wood from feature, depth 45 cm from surface	Clay loam	15170 ± 70	18,317 - 17,868	Beta - 70982 CAMS - 12038	hearth
2	N3 E2	III	Organic sediment (ash) from feature, depth 55 cm from surface.	Clay loam	15,347 ± 190	18,659 - 17,845	GX - 20065	hearth
3	N4 E4	II	Charcoal from feature, depth 35 cm from surface	Clay loam	150 ± 1600	290 - 0	Beta - 70981 CAMS - 12217	
4	N4 E4	IIA	Ash and charcoal from feature, depth 54 cm from surface	Clay loam	15,150 ± 70	18,298 - 17,849	Beta - 70983 CAMS - 12039	Disturbance (rejected)
5	N4 E4	II	Land snail shell from feature, depth 55 cm from surface	Clay loam	8305 ± 90	9,456 - 8,991	OAEP - 1178	
6	N4 E4	IIA	Riverine shell from feature, depth 70 cm from surface	Clay loam	10,030 ± 110	12,127 - 10,992	GX - 20066	Disturbance (rejected)
7	N4 E4	II	Land snail from shell-midden, depth 60 cm from surface	Clay loam	7540 ± 180	8646 - 7940	OAEP - 1179	
8	N4 E4	III	Burnt clay mixed with ash and charcoal, depth 75 cm from surface	Clay loam	6,110 ± 60	7,168 - 6,801	Beta - 70984 CAMS - 12218	
9	N4 E4	III	Land snail depth 85 cm from surface	Clay loam	15,640 ± 150	18,874 -18,212	OAEP - 1181	
10	N4 E4	IV	Land snail from shell-midden, depth 90-100 cm from surface	Clay	15,640 ± 150	18,874 -18,212	OAEP - 1181	
11	N4 E4	IV	Land snail from shell-midden, depth 90-100 cm from surface	Clay	23,165 ± 330	Too old the calibrate	GX - 20067	

Beta= Beta Analytic Inc., (USA), OAEP= Office of Atomic Energy of peace of Thailand, GX= Geochron Laboratories (USA)

Table 1.3.4a Radiocarbon determination from Lang Kamnan Cave, Western Thailand (Source: Shoocongdej 1996)

Sample No.	Unit	Cultural layer	Material and Context	Sediment	Conventional Age B.P (±1 s.d.)	Calibrated age Range B.P (±2 s.d.)	Lab No.	Remarks
12	N4 E4	IV	Land snail shell from shell-midden, depth 125 cm from surface	Clay	30,880 ± 760	Too old the calibrate	GX - 20068	
13	N4 E4	IV	A piece of wood, depth 130 cm from surface	Clay	160 ± 60	303 - 0	Beta - 70986 CAMS - 12040	Modern roots (rejected)
14	N4 E4	IV	Lands nail, depth 140 cm from surface	Clay	26,920 ± 210	Too old the calibrate	Beta - 70985	
15	N2 E4	II	Land snail, depth 40 cm from surface	Clay	7990 ± 100	9197 - 8,506	GX - 20069	
16	N2 E4	II	Land snail, depth 30 cm from surface	Clay	7740 ± 140	8956 - 8180	OAEP - 1192	
17	N2 E4	II	Riverine shell, depth 65 cm from surface	Clay	16,170 ± 175	19,531 - 18,662	GX - 20070	
18	N2 E4	III	Land snail, depth 95 cm from surface	Clay	20,020 ± 240	Too old the calibrate	GX - 20071	
19	N2 E4	III	Land snail, depth 105 cm from surface	Clay	18,280 ± 320	22,680 - 20,941	OAEP - 1193	
20	N2 E4	IV	Land snail, depth 115 cm from surface	Clay	17,130 ± 230	21,047 - 19,574	OAEP - 1194	
21	N2 E4	IV	Land snail, depth 135cm from surface	Clay	21,120 ± 460	Too old the calibrate	OAEP - 1195	
22	N2 E4	IV	Land snail , depth 145 cm from surface	Clay	27,110 ± 500	Too old the calibrate	GX - 20072	

Beta= Beta Analytic Inc., (USA), OAEP= Office of Atomic Energy of peace of Thailand, GX= Geochron Laboratories (USA)

Table 1.3.4b Radiocarbon determination from Lang Kamnan Cave, Western Thailand (Source: Shoocongdej 1996

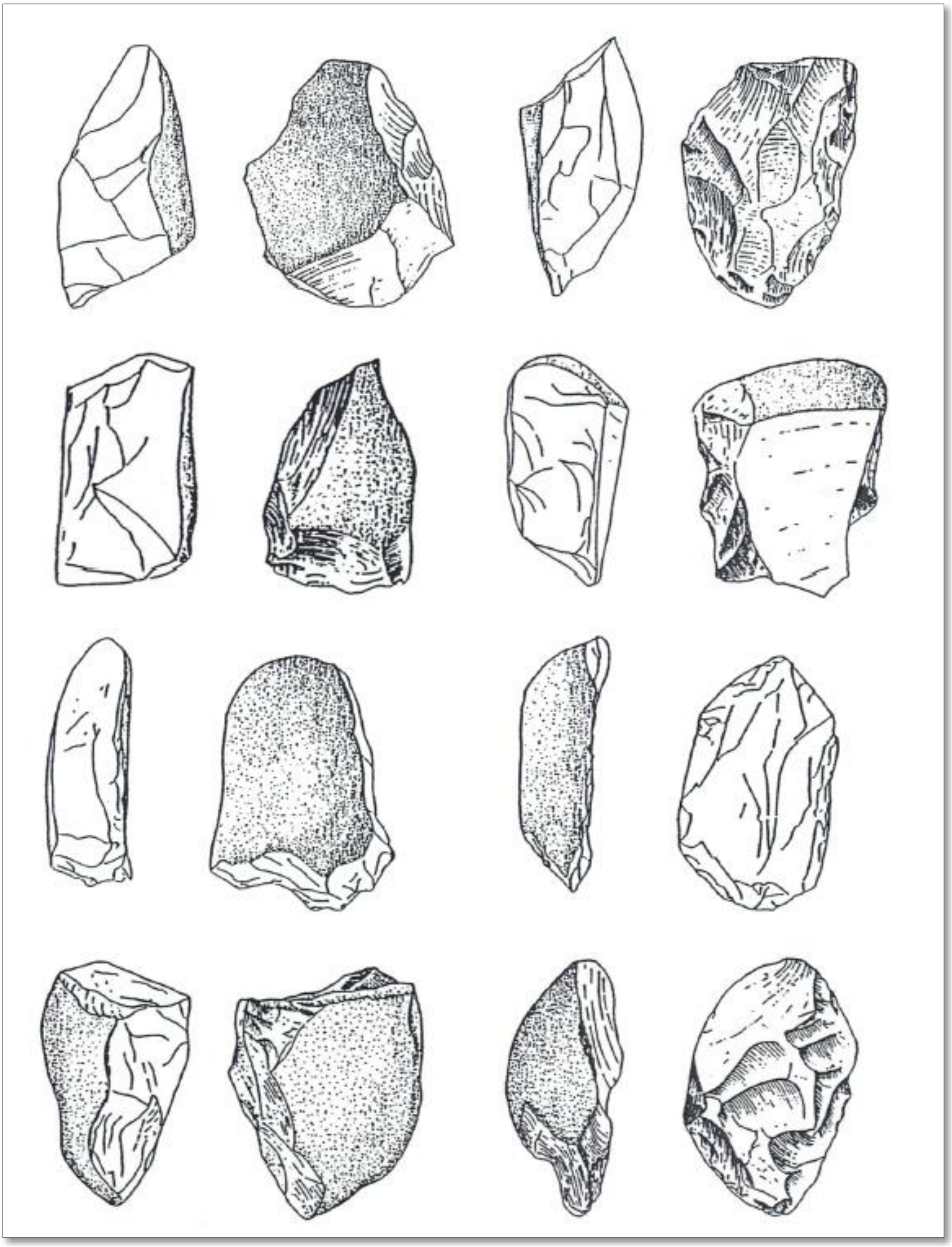


Figure 1.3.7 Stone artefacts from Lang Kamnan Cave, Western Thailand (Source: Shoocongdej 1996)

1.3.5 Ban Rai Rockshelter

Ban Rai Rockshelter is located at Pang Mapha district, Mae Hong Son province, Northwestern Thailand. Formerly, Thai archaeologists (Fine Arts Department 1987; Sawatsalee 1998; Treerayapiwat 1998; Krajaechan 2001) surveyed and studied this region, but did not excavate in this site. In 2001-2002, Shoocongdej and staff from the Highland Archaeology Project, systematically excavated at Tham Lod and Ban Rai Rockshelters. The project was supported by Thailand Research Fund (TRF) and Silpakorn University.

The site of Ban Rai is one of the largest caves and sinkholes, located in the karst landscape of this region. The rockshelter has been measured ca. 105 x 42 m, closely resembling a circular sinkhole in the shape. The excavation was preceded by the creation of a 5x5 m. grid system over the entire site. Then three areas were selected for excavation (Treerayapiwat 2005: 232). The aim of this excavation was to provide detailed cultural chronology of Log Coffin burials, along with other evidences of settlement such as investigating the palaeoenvironment at Pang Mapha district, in North-western Thailand (Shoocongdej 2001, 2002, 2003, 2004, 2005, 2007; Pureepatpong 2004, 2006; Treerayapiwat 2005; Marwick 2008). Importantly, three areas had been notified for excavation in this site. A wide diversity of archaeological remains was noted like the log coffins, stone tools, potteries, animal bones and rock paintings (Treerayapiwat 2005; Pureepatpong 2004, 2006).

According to Shoocongdej (2000), the presence of potsherds and iron tools have defined two separated cultural components at the site. The pre-Log Coffin culture undoubtedly contained an abundance of artefact assemblages such as stone tools, animal bones and shellfish remains. Besides, the Log Coffin culture comprised of artefact assemblages with the presence of potsherds and iron tools.

Cultural sequences	**Characteristic of the archaeological materials**	**Date (B.P)**
Pre-Log Coffin culture (Component I)	***Area 1:*** - Core tools, flakes, resharpened flakes, manuports (pebbles & cobbles) and hammers were present the entire spectrum of production. - Animal bones and shell remains were always exposed in large abundance in this component. ***Area 2:*** - Archaeological remains including lithic and faunal remains were similar to the other sectors, - The majority of artifacts were rather found within ash layer. This area produced a burial pit, roughly circular in shape and around 30 cm deep, which contained a primary flexed skeleton. - The skeleton was extremely fragile. The preliminary analysis of skull and bones has identified the body as a male. - A charcoal sample has taken from near the left humerus of the skeleton has been dated to ca. 9800 B.P	Layer 2, area 1, Beta-168215, 9400 ± 120 B.P Layer 4, area 1, Beta-168216, 10,600 ± 40 B.P Layer 4, area 2, Beta-168218, 9410 ± 80 B.P

	Area3: - Archaeological assemblages were similar to the other sectors, including a large proportion of lithic artefacts and faunal remains. - There were more archaeological remains than in other trenches. Many ashes had been combined with the natural soil, followed through the excavated levels.	Layer 5, area 3, Beta-168221, 8850 ± 50 B.P
Log Coffin culture (Component II)	- The excavations produced no suitable samples for dating in this component. - Grave (1995) concluded that the coffin burials in the region can be dated generally to ca. 2100- 1200 B.P, and Ban Rai coffins can be assigned to this period. - Archaeological evidences used to identify this component, including the wooden posts that had evidently been used for supporting the coffins. Potsherds and iron tools were found within the first few excavated levels of each trench. - Stone artifacts such as sumatraliths, short axes, wasted cores and flakes, and utilized cores and flakes, animal bones and shellfish were throughout followed the excavated levels. - Most of potsherds were likewise typed on surfaces, which have been designed by the cord-marked.	

The evidence from Ban Rai Rockshelter site has contributed to understand human activity and cultural changes during the late Pleistocene through to the late Holocene period in the district of Pang Mapha, Mae Hong Son province (Treerayapiwat 1998, 2005; Shoocongdej 2000, 2003, 2007). The pre-Log Coffin culture approximately aged between the late Pleistocene and early Holocene, based on radiocarbon dating in between 12,500 and 8000 B.P. Generally, the assemblages of this component were composed of stone tools, abundance of faunal remains, and a primary flexed burial (Treerayapiwat 2005; Pureepatpong 2006). In addition, the flexed burial, indicated to the Pre- Log Coffin culture, absolutely represented a stone-using period when they were hunting and collecting on basis of the subsistence pattern of the people, using the site (Treerayapiwat 2005). The analogies with the flexed burial suggested that the foraging activity at the site was rather contemporary with the late Pleistocene to early Holocene culture of the Malay Peninsula and islands of Southeast Asia (Anderson 1990; Bellwood 1985).

In another perspective, one of the most significant components of Log Coffin culture was just layer below the surface of Ban Rai Rockshelter. It was fitfully related to artefacts from recovering. This component was quite high proportion of mixed ash deposits, particularly in the area 1 (Treerayapiwat 2005; Shoocongdej 2005, 2007). The artefact assemblages were similarly typed and designed to those recovering from Log Coffin sites across the Pang Mapha region (Shoocongdej 2000, 2005, 2007; Treerayapiwat 2005). The Log Coffin culture was probably dated to ca. 2100-1200 B.P, and this area yielded the human remains, potsherds, and iron tools (Pureepatpong 2004, 2006; Treerayapiwat 2005). Also, the composition of the artefact assemblages provided the main basis for the separation of the components. These components have clearly emphasized the changing use of the Ban Rai Rockshelter from a primarily habitation to an exclusively burial site.

However, the evidenced surface of Ban Rai Rockshelter was likewise supposed from Spirit cave, which first excavation was carried out by Gorman (1970, 1971b, 1972) at Pang Mapha district. This site was indicated on the excavation, apparently earliest evidence of habitation, and was about 12,000 B.P. Moreover, Gorman (1970) defined two culture periods in the cave sequences, labeled the upper and lower Hoabinhian culture.

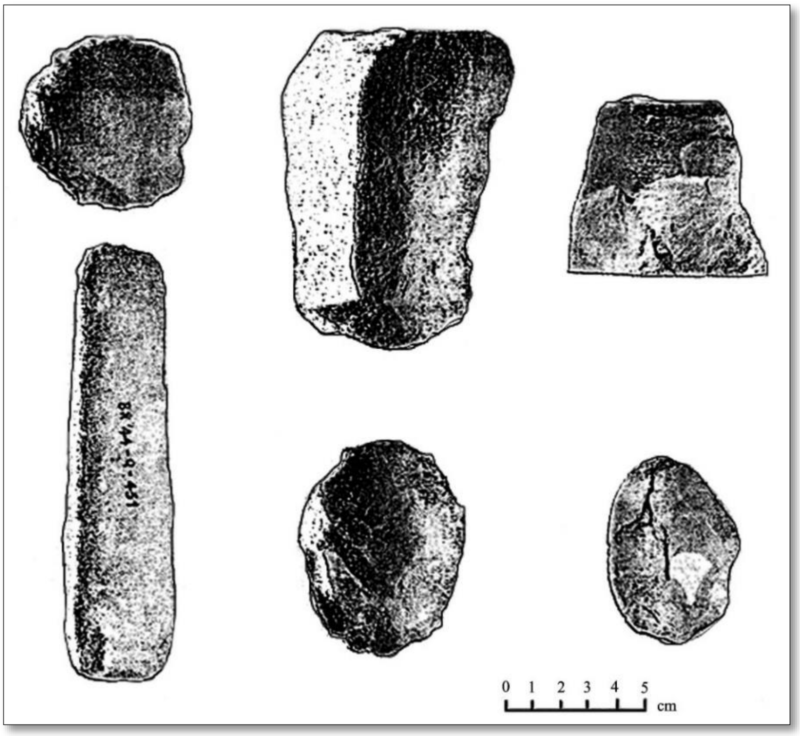


Figure 1.3.8 Stone artefacts from Ban Rai Rockshelter, North-western Thailand (Source: Shoocongdej 2005)

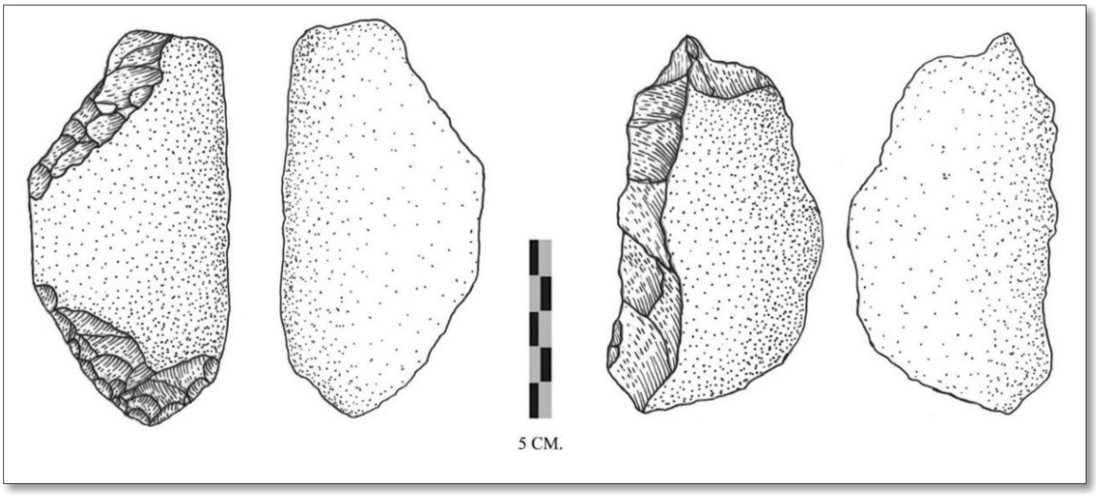


Figure 1.3.9 Stone artefacts from Ban Rai Rockshelter, North-western Thailand (Source: Treerayapiwat 2005, drawing by Chitkament)

Lab No. Sample data	Area	Level	Layer	Archaeological context	Measured radiocarbon age	$^{13}C/^{12}C$ Ratio	Conventional radiocarbon age
Beta-168215 Sample: MHSBRA 1-073	1	4	2	Hearth and ash mixed with many flakes	9400 ± 120 B.P	-25.0* 0/00	9400 ± 120 B.P
Beta-168216 Sample: MHSBRAR 1-480	1	14	4	Soil-mixed ash above sterile layer (early habitation?)	10,600 ± 40 B.P	-28.80/00	10,600 ± 40 B.P
Beta-168217 Sample: MHSBRAR 2-146	2	-	4	Charcoal in primary flexed burial collected in around the left humerus	9820 ± 50 B.P	-30.80/00	9720 ± 50 B.P
Beta-168218 Sample: MHSBRAR 2-398	2	5	4	Hearth and ash mixed with animal bones	9410 ± 80 B.P	-25.0 */00	9410 ± 80 B.P
Beta-168219 Sample: MHSBRAR 2-822	2	-	4	On west profile, above sterile layer	10,270 ± 50 B.P	-28.40/00	10,210 ± 50 B.P
Beta-168220 Sample: MHSBRAR 3-850	3	17	3	Charcoal and ash feature with lithic artefacts, animal bones	7300 ± 40 B.P	-28.80/00	7250 ± 40 B.P
Beta-168221 Sample: MHSBRAR 3-1070	3	22	5	Charcoal and ash feature above sterile layer	8890 ± 50 B.P	-27.70/00	8850 ± 50 B.P
Beta-168221 Sample: MHSBRAR 3-1105	3	23	5	Charcoal found near animal teeth in habitation layer	8270 ± 40 B.P	-29.70/00	8190 ± 50 B.P

*Beta = Beta Analytic, Inc., USA

Table 1.3.5 Radiocarbon (^{14}C) Dates from Ban Rai Rockshelter, Pang Mapha District, North-western Thailand (Source: Treerayapiwat 2005)

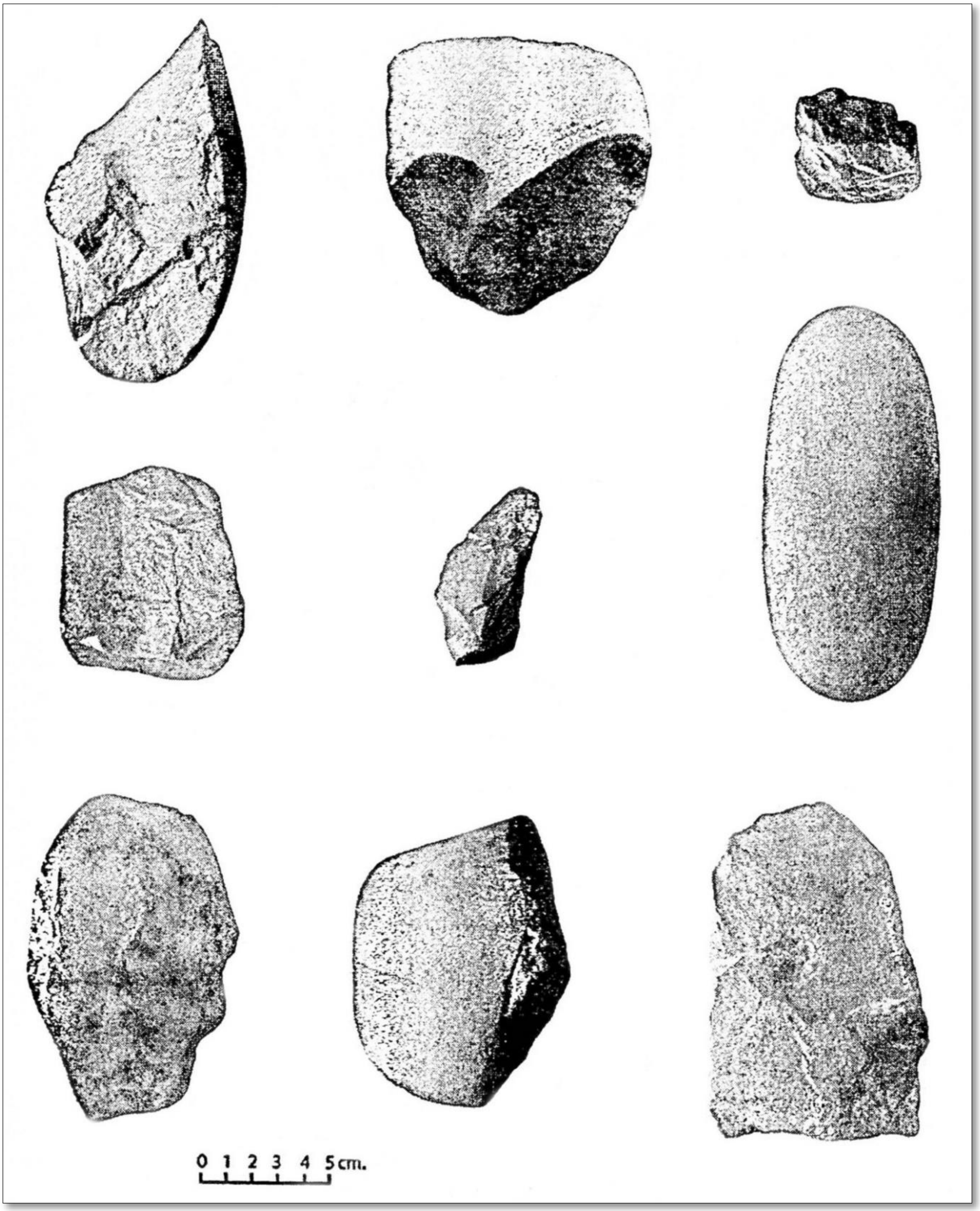


Figure 1.3.10 Stone artefacts from Ban Rai Rockshelter, North-western Thailand (Source: Shoocongdej 2005)

1.3.6 Spirit Cave

The site of Spirit cave was known by local hunters in the Thai-yai village of Mai Sang Nam, at Mae Hong Son province, North-western Thailand. They directly informed Gorman about this site and he hired excavators in 1966. Spirit cave is a very small shelter. It actually was a complex of three separate areas, weathered into the limestone butte by percolating rain water. Generally, the surface deposit was very disturbed, but the site produced a well-defined stratigraphic sequence. The radiocarbon determinations, mainly from *in situ* charcoal deposits indicated that the shelter was occupied from about 12,000 years B.P to about 7500 years B.P. It was difficult to tell exactly about the nature of the shelter's occupation (Gorman 1970, 1971b, 1972). The horizontal deposits of this site had been divided into five layers and two cultural levels as following:

Cultural levels	**Characteristic of the archaeological materials**	**Date (B.P)**
Cultural level I (Hoabinhian)	- The coarse grained quartzite was the most commonly used stone through all layers. - Stone artefacts were explored such as large unifacially worked pebbles cores, grinding stones, retouched and utilized flakes, including some sumatraliths. - The grinding stones were formal types, as well as small grinding surfaces on the river pebbles. Most of raw materials came from quartzite and basalt. - Ochre (iron oxide) was frequently scattered in these layers, and all grinding surfaces had been associated with traces of the pigment. - The retouched and utilized flakes were interesting, and the microscope analysis had enabled to recognize damage patterns. - The characteristics of these levels were small calcite blades produced by pressure from large calcite fragments. They show a damage pattern perpendicular to their longitudinal axes. - A characteristic damage pattern of abraded, semicircular or concave deformations, apparently retouched all along one edge. - Many faunal remains were found; large mammals: bovids, cervides, suids and primates; small mammals: bats, rat, squirrels, reptiles, snakes, turtles), birds, fish and shellfishes. - Three holes, with fragment of the bamboo, still upright in place, extended into layer 3.	
Cultural level II	- New artefact types, including flakes, polished quadrangular adzes, small ground and polished slate knives, cord-marked and burnished ceramic. - The Hoabinhian described in the cultural level I, continued to be in use through layer1 of cultural level II. - One completed adze, one broken adze fragment, and one adze blank were recovered from layer 2. These artefacts are made of limonite. - Two small slate knives were discovered from the surface of layer 2, and two fragments were found in the layer 1.	Layer 2, sector B2-B3, FSU-317, 7400 ± 300 B.P Layer 2, sector A2, 7905 ± 390 B.P

	- Faunal remains were identified: large mammals (cervids, suid and primates) and small mammals (bats, rats, reptiles, birds, squirrels, as well as fish, shellfish and turtle. - Floral remains like *Palmae areca*, *Piperaceae piper*, and *Burseraceae canarium*. - Iron oxide or fire baked clay fragments were occasionally present in this layer.	Layer 2, sector A2-B2, Gak-1846, 8850 ± 200 B.P

According to Marwick (2007), preliminary results published in 1970, completely showed two cultural levels at Spirit cave. The older level *ca*.12,000 - 9000 B.P contained Hoabinhian assemblages with large unifacially worked cobble tools, grinding stones, retouched and utilized flakes. The younger level *ca*. 9000- 7000 B.P rather contained Hoabinhian assemblage with flaked, quadrangular adzes, polished slate knives, cord-marked and burnished ceramics (Gorman 1972: 95).

These stone artefacts formed a small part of Gorman's analysis, as it also included ceramics, animal and plant remains. Therefore, the general term Hoabinhian based on a simple description of the stone artefacts implied an ecological dimension (Gorman 1972: 82; Pookajorn 1984, 1988; Marwick 2007, 2008).

1). A generally unifacially flaked tool tradition made primarily on water rounded cobbles and large flakes detached from these cobbles;

2). Core tool "sumathralith" made by complete flaking on one side of a cobble and grinding stones also made on rounded cobbles;

3). A high incidence of utilized flakes (identified from edge-damage characteristic)

4). Fairly similar assemblages of food remains including remains of extant shellfish, fish and small to medium-sized mammals;

5). A cultural and ecological orientation to the use of rockshelters, generally occurring near fresh water streams, in an upland karstic topography (though Hoabinhian shell middens indicated at least one other ecological orientation);

6). Edge-ground tools and cord-marked ceramics occurring (though perhaps as intrusive elements), individually or together, in the upper layers of Hoabinhian deposits.

Overall, these attributes were well established in Hoabinhian sites over the largest part of Mainland Southeast Asia. As with the work of others, the weaknesses of Gorman's publications is the absence of detailed discussion or data about the stone artefacts. According to Marwick (2007, 2008: 15), this was probably due to Gorman's interest in agriculture origins at Spirit Cave and the importance of botanical and zoological remains in his project.

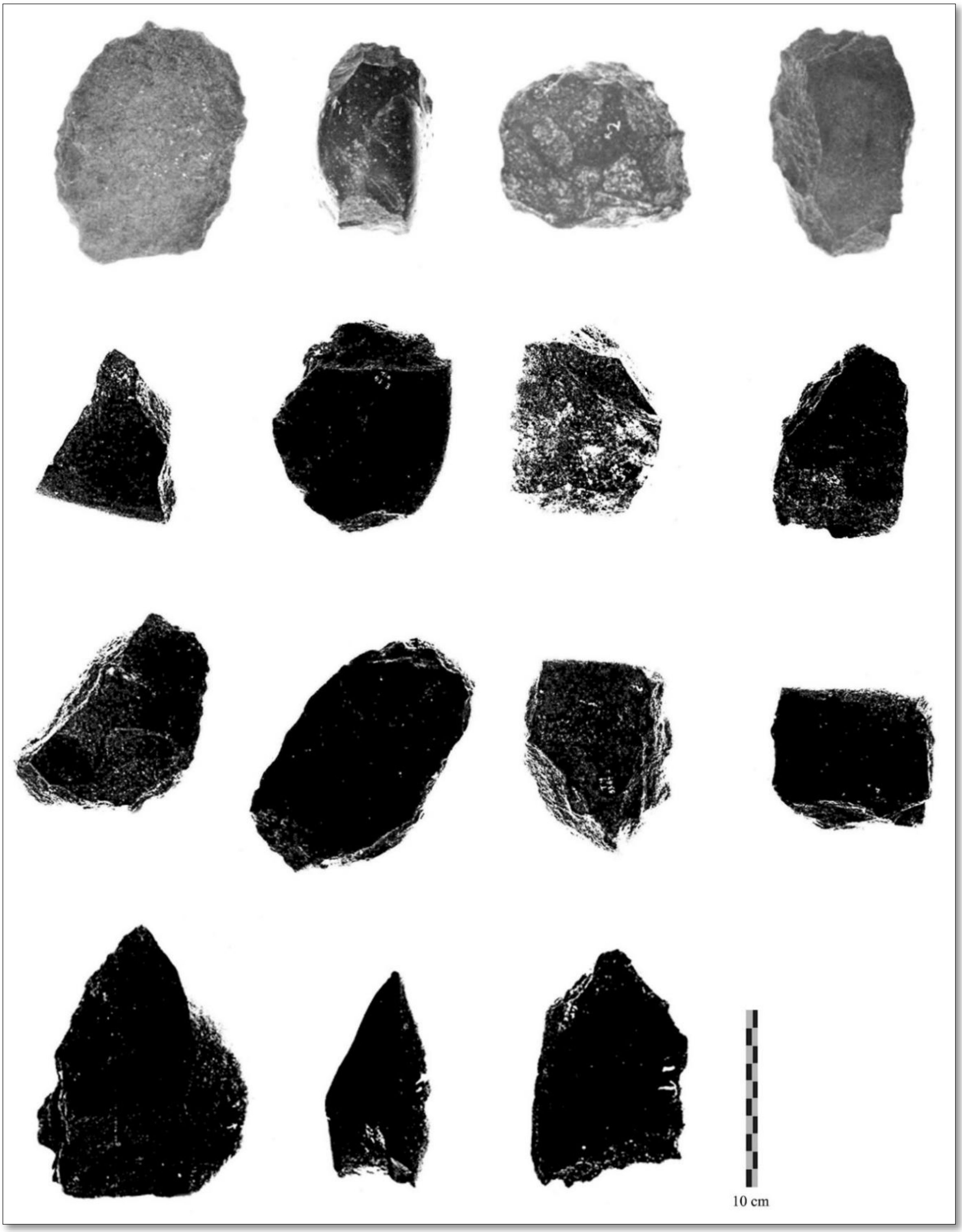


Figure 1.3.11 Stone artefacts from Spirit cave, North-western Thailand (Source: Gorman 1971)

Lab No.	Square	Excavation layer	General layer	Uncorrected date +	Corrected date +	Range 1^{sd}	Range 2^{Sd}
FSU 317	B2-B3	2	1	7400 ± 300	7622 ± 300	7922 - 7322	8222 - 7022
FSU 314	A2-B2	2	2	7905 ± 390	8142 ± 390	8530 - 7750	8922 - 7362
Gak 1846	A2-B2	2	2	8550 ± 200	8806 ± 200	9006 - 8606	9206 - 8406
TF 802	B2-B3	2a	2a	-----------------	8750 ± 140	8890 - 8610	9030 - 8470
FSU 318	B3-B4	2a	2a	8520 ± 290	8776 ± 290	9066 - 8486	9356 - 8196
Gak 1845	B2-C2	5 (surface)	4	9180 ± 360	9455 ± 360	9815 - 9095	10,175 - 8735
TF 803	B3	3	4	-----------------	10,390 ± 310	10,700 - 10,080	11,010 - 9770
FSU 316	B2	5	4	10,910 ± 580	11,237 ± 580	11,817 - 10,130	12,397 - 10,077
FSU 315	C2	3 (mixing)	3/4	11,350 ± 560	11,690 ± 560	12,250 - 11,130	12,810 - 10,570

*FSU = Florida state University; *Gak = Gakushuin University; *TF= Tata Institute of Fundamental Research

+ Radiocarbon determination base on Libby half-life of 5570 years.

+ Radiocarbon determination corrected to half-life of 5730.

Table 1.3.6 Radiocarbon dates from Spirit Cave, North-western Thailand, in Year B.P, (After Gorman 1968; source: Pookajorn 1988)

1.3.7 Ongbah cave

The site of Ongbah cave is located in the hills between rivers of Kwae Yai and Kwae Noi at Sri Sawat district in Kanchanaburi province, Western Thailand. The cave is approximately 10 kms from boat-landing of Sri Sawat. In order to reach the cave, one has to walk about 700 meters through scrub wood and elephant grass, and then, climb the hillside for another 300 meters (SØrensen 1988). Ongbah cave had for sometime been subjected to dig by local farmers. Traditionally, they have regularly dug in the caves for bat guano, prominently used as fertilizer for plantation. In doing this, they had gradually removed the upper parts of the soil deposit, which once contained the wooden coffin burials of the early Metal ages (SØrensen 1988: 95).

The northern entrance (Hall 4) of the cave really looked at anything but impressive. The entrance was low and crescent-shaped, mainly due to rather extensive depositions of soil. Beyond the entrance was a big dome-shaped chamber with stalactite formations. It was divided into two rooms, for conveniences called Halls 1 and 2 (SØrensen 1988: 96). From the rear end, left-hand side of Hall 2, a narrow passage was further extended into the hill. This passage, called the Gallery because of its particularly beautiful stalactites, leaded to another big chamber called the Hall 3, and the back part was Hall 4 (SØrensen 1988). Therefore, the context of excavation and observation had fixedly been divided into different halls as following:

Location of the cave	**Observation and excavation of Ongbah cave**	**Date (B.P)**
Hall 4	- In this hall it was possible to distinguish between three main horizons in the 1.5 m deep deposits. - The stratigraphy was subdivided into 7 layers by several pockets. The thinner layer was the white and grey ashes, including soft and loose soil with a high content of charcoals. - Nodules of melted bronze were discovered in this hall. - Cobble tools of Hoabinhian type were found between Halls 3 and 4 in the middle horizon, along with a few chips and flakes. - Some burials in supine position and without fixed orientation were exposed. These were probably associated with grave goods and pottery which could be linked with the Ban Kao culture. - Dissolution of limestone or other calcareous materials had taken place in the cave floor. It perhaps was under the influence of acid from the wood of the coffins.	- Layer 2, (from the top deposit), 240 ± 100 B.P - Layer 5, 3960 ± 100 B.P
Hall 3	- Raiders had here penetrated the calcareous floor, almost in front of the “Alter”, leaving a crater-like hole to a depth of more than 2 meters. - Original top soil was a being only 40-50 cm in thickness. It was just enough to cover the coffins, but did not report about two kettledrums here. - Many coffins were piled in this hall, especially in the behind and south of the “Alter.” A few cobble tools of Hoabinhian type, beside Neolithic sherds and iron artefacts, were rather scarce in this unit.	

Gallery	- The conditions of Gallery were almost similar to Hall 3, except some of the deposits, met in Hall 4, also present here. - Two of the drums, described later, were showed in the Gallery behind some huge fallen stalactites, but not *in situ*. - A coffin was the only one found *in situ*. It was obviously used to make fire during prehistoric times. The fire had seriously affected one of its sides. From this part, charcoal samples were taken. - Soil, heaped from the Gallery, contained iron weapons, tools and sherds of miniature vessels, contented of the coffins. - A few cobble tools and Neolithic sherds were found here, but the original assemblages probably came from either of the big halls.	- Analysis of wood showed it belonged to *Dahlbergia* sp., and was thus in concordance with the fresh wood; 2180 ± 100 B.P
Hall 1 and 2	- Doubtless, the main prehistoric activities took place in Hall 1 and Hall 2. - Most of deposits were spread on the field, and in the vegetable gardens in the neighborhood. - In this horizon, there were wooden coffin burials. - Two drums had actually been found in this part of the cave during the excavation. - Soil deposits could be subdivided into three layers on the basis of differences of colour, and on the basis of ash horizons with charcoal, on the top deposit in Hall 4. These layers contained animal bones like bones of fish and birds. - A lot of cobble tools of Hoabinhian type. Most of short axes and Sumatraliths had been extraordinarily made by workmanship. - A few shells of Canarium were also found in this hall. - A supine skeleton with iron artefact, but without coffins. - No evidence of cultivated plants was discovered here, even though conditions were rather favorable for their preservation. - Postholes in the upper part of this layer were not evident in the cave. The occupants had lived on a platform - The associated grave goods of iron weapons tools and single vessel could be assumed to be contemporaneous with the coffin burials.	- Bottom of the first Hoabinhian layer from the top; 9350 ± 140 B.P - Bottom of this third layer, 11,180 ±100 B.P

The site of Ongbah cave had been occupied as living place by some late Paleolithic and Mesolithic hunters (SØrensen 1988). The archaeological remains overwhelmingly showed that local population later used the cave as only a burial ground. The most interesting of the burial were the boat shape of wooden coffins. These seemed to connect with the kettledrums. Moreover, two bifacial handaxes are well known in the Hoabinhian context from the Halls 1 and 2 of Ongbah cave, where the Hoabinhian habitation layers were dated between 9230 ± 180 B.C and 7400 ± 140 B.C. Pookajorn (1986), in one of his studies on the excavated findings from Kao Talu, Ment and Heap caves, in the Ban Kao area, Kanchanaburi province, described two bifacial tools. One of these was a bifacial handaxe similar to the almond-shaped one from Ongbah cave.

No.	Specimen	Archaeological layer	Radiocarbon date (B.P)	Cultural level
1	K-1300	?	2180 ± 100	Metal age (Iron?)
2	K-1299	V	3960 ± 100	Metal age (Bronze?) (possibly contaminated date)
3	K-1398	II	4240 ± 100	Bronze?
4	K-1362	I	9350 ± 140	Hoabinhian
5	K-1341	II	9750 ± 150	
6	K-1365	III	9970 ± 150	
7	K-1364	II	10,010 ± 150	
8	K-1363	II	10,090 ± 160	
9	K-1340	III	10,760 ± 170	
10	K-1366	III	11,180 ± 180	

Table 1.3.7 Radiocarbon Results from Ongbah cave, Kanchanaburi Province, Western Thailand (Source: Bronson and White 1992)

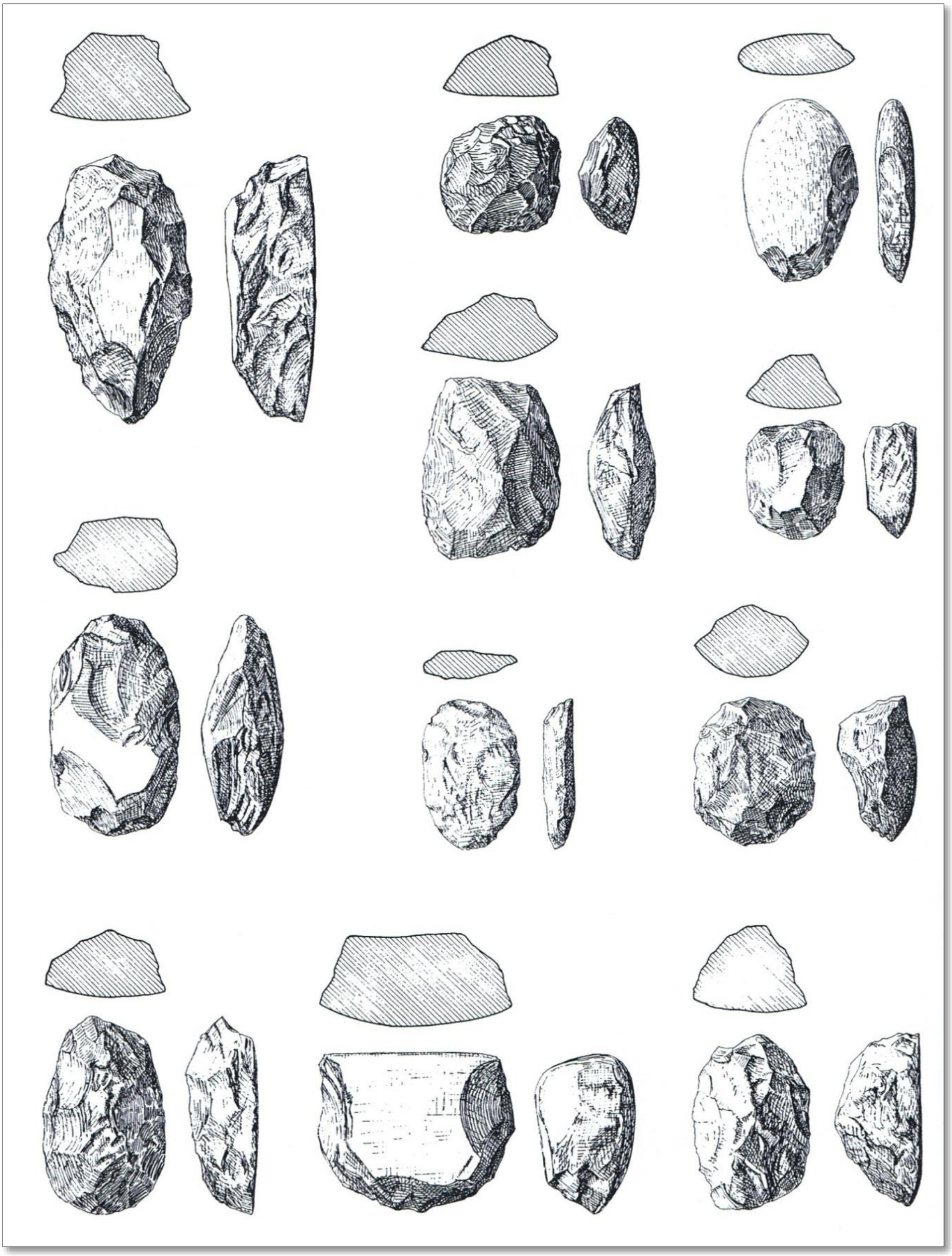


Figure 1.3.12 Stone artefacts from Ongbah cave, Western Thailand (Source: SØrensen 1988), no scale in original

1.3.8 Sai Yok

The site of Sai Yok is located at Kanchanaburi province, Western Thailand. A Thai-Danish Prehistoric Expedition made excavation in 1960 to 1962 (van Heekeren 1962). Over 50 square meters had been excavated. Some sections were 425 cm deep below the surface. No radiocarbon dates were obtained because of lack of datable of material but the maximum age was estimated by excavators to about 10,000 years before the present (B.P).This site was attributed to the Mesolithic or Hoabinhian period.

According to van Heekeren and Knuth (1967), the site of Sai Yok revealed a fully representative collection of cobble tools, comprising more than 1500 artefacts. Most of the stone implements which had been exposed during the course of controlled excavation were made from river cobbles in quartzite, quartz, sandstone and schist. In the Sai Yok site five successive culture layers had been identified, like cobble industry (Hoabinhian proper), Neolithic, Bronze Age and Historical period, without any chronometric determination. Furthermore, stone assemblages were divided into three major categories of artefacts. These materials had been classified by van Heekeren and Knuth (1967) as massive high-domed tools, sturdy choppers with a minimum of trimming, and proper Hoabinhian implements. The cobbles were only flaked on one face, also providing a straight cutting-edge. Therefore, all the typological analysis of Sai Yok resulted in the following classification:

Typological Analysis	**Characteristic of the artefact assemblages**
Pebble tools industry	*1). Massive high-domed tools* - Horsehoof: steep and stepped retouch, all around the edges of the upper face, produced a round massive cobble-tool in the shape of a horsehoof. - Flat iron: the technique of manufacture was the same as that of the “horsehoof” *2). Chopper* - Side choppers: coarsely flaked along one of the longer sides. - End choppers: flaked at the end, perpendicularly to the main axis of the tool. *3). Hoabinhian proper* - Almond picks: oval shaped cobbles ending in a point and flaked on one face only. - Triangular picks: generally made of large boulder flakes. - Edge-ground and partly ground cobble tools: a few ground cobble tools were found. - Cortex disc: the technique of manufacture of cortical discoidal scarpers was quite simple. The tools were fashioned in the same way as the cortical oval sumatraliths. - Flake disc: the tools were made of flakes detached from round cobble or boulders. - Narrow sumatralith: differently from the former, it was longer and narrower, and made of parallel-sided cobbles. - Edge-chipped bifaces: alternate trimming on both faces was confined to the periphery. The type was rarely found at Sai Yok. - Thick short-axes: fashioned by breaking a thick oval cobble transversally into halves, each showing a straight-cut butt and flaked on one face only. - Pointed short-axes: generally asymmetric and ending in a point.

	4). Bladelets - These micro-blades were made by a rather clumsy blade technique. Most of them seem to have been struck from a pebble or core with unprepared striking platform. *5). Bone awls and shell scrapers* - Apart from the lithic material, there were some cylindrical, fire-hardened, bone awls, which might be included in the upper part of the pre-ceramic horizon, like the one where bladelets had been exposed. There was evidence that sometime shells were worked as tools.
Neolithic	- The Neolithic period at Sai Yok was based on burial remains in the big cave, which were the best preserved. There were scattered sherds, vessel fragments, polished stone axes and adzes, and biconical spindle whorls of backed clay and stone. *1). Pottery* - Globular pots: in colour, body covered with cord or mat impressions and smooth below the mouth. - Bowls: thin-walled, faces coated with a slip and polished, black-brown or shiny black in colour. *2). Polished quadrangular axes, adzes and variants* - Besides pottery, the burials contained polished stone axes and adzes; more specimens of this kind were partially collected outside the graves in the course of excavation. - The axes and adzes were generally small with keen cutting-edges, showing a beautiful polish except at the butt (the end opposite the cutting-edge). - The axe blades might be fitted to knee or elbow shafts of wood, presumably mounted with the cutting-edge at right angles to the handle. *3). Polished shouldered adzes* - The shouldered or stemmed axes and adzes were discovered in the big cave. *4). Miscellaneous* - Relics of the Neolithic period were perforated spindle whorls, especially made of stone or baked clay.
Bronze Age	- A round bell of bronze containing a pellet; covered with raised line spirals with a bronze ring on the top and slit on the lower side. - Polished stone adze, single beveled; black metamorphic rock, asymmetric and inspired by a metal form. - Finger-ring made of thin brass wire. - Carnelian cylindrical bead with six facettes. - Round pale-blue glass bead, small coiled globular vessels and pots were found in the big cave.
Historical remains	*1). Urns* - Cremation was then practiced as shown by the presence of urns containing ashes of cremated bodies. *2). Chinese ware* - *Sino-Annamese*: a box with flat-topped cover of hard, whitish-buff fine grained porcelain. *3). The fragments of Buddhist bronze*

	- A small head of a crowned Buddha was not found in the digging, but discovered in a small niche at the entrance of the big cave. *4). Iron tools* - It recovered with little surface or no stratigraphy for guidance. The findings were surely recorded for what they might be worth.

In terms of the positive aspect of the stone artifacts, they received attention from John Matthews (1964) who intently used an alternative approach. He worked on the cobble-tools collection amassed in Sector X, based on the talus slop on the terrace at Sai Yok. Also, he obtained the specimens in Sector C in the rockshelter. His statistical approach might have proved of value and made an important contribution towards the re-evaluation of the cobble flaking principles (Marwick 2007, 2008). According to his work, he could not define Colani's Hoabinhian types in terms of constantly recurring attributes. The Hoabinhian types did not exist at Sai Yok and Hoabinhian artefacts have been reflected and rather continued in different shapes and sizes (Matthews 1964; Marwick 2007, 2008).

H.R van Heekeren (1967) suggested that "no hard and fast rules could be made to differentiate the many types of implements, as some types almost imperceptibly merged into others." However, more objective statistics in Matthew's studies led to some empirical support to van Heekeren's observation. Also, they postulated a basal date of 10,000-8000 years for the Hoabinhian horizon. SØrensen (1988) argued for a late Pleistocene to early Holocene antiquity, on the basis of the typology; the short axes from floors 2-4 in the Sector A of the excavation, prominently matched with those from the cave of Ongbah. The Hoabinhian at Ongbah cave dated between 11,000 and 9000 years B.P (SØrensen 1988).

Also, they suggested that the large tools were markedly held in hand and the heaviest in both hands, whereas the smaller types such as the scrapers, the oval "sumatraliths" and short axes, were fitted with wooden handles. As Movius and van Heekeren had advisedly notified, stone implements found from Sai Yok were quite similar to those from Myanmar, Malaya, India and China. It was suggested to group them as Southeast Asian Pleistocene stone assemblages. They don't contain bifacial, prepared core or standardized blade technologies like those found in Africa, Europe and west Asia (SØrensen 1988).

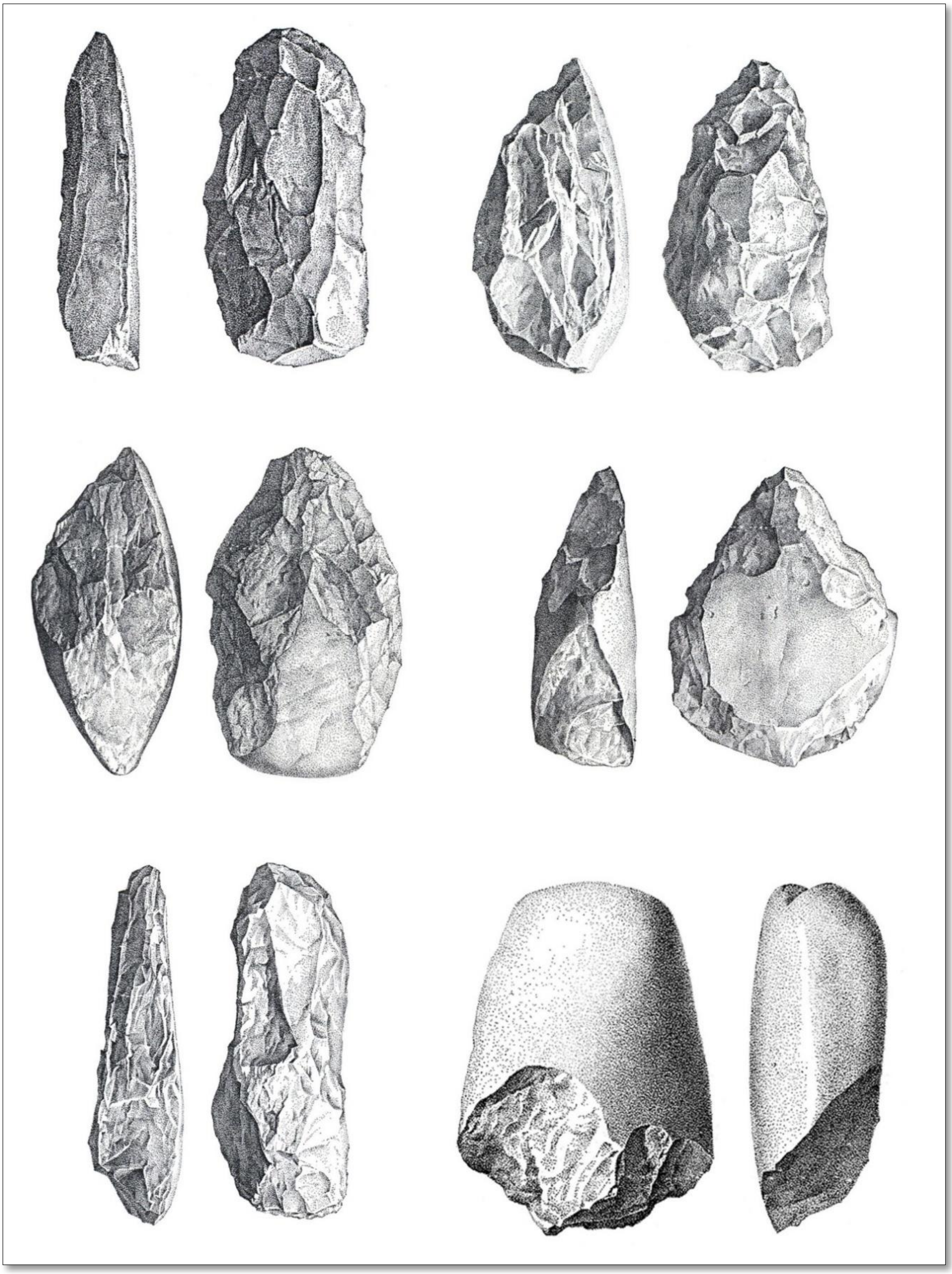


Figure 1.3.13 Stone artefacts from Sai Yok cave, Western Thailand (Source: van Heekeren and Knuth1967), no scale in original

3.1.9 Ban Kao sites (Khao Talu, Ment and Heap Caves)

Ban Kao is a small hamlet in the western part of central Thailand. It belongs to Chora khe Phuk village, Kanchanaburi province. This area is situated on the terrace that was formed by the Kwae Noi River. The eastern and western parts of Ban Kao are occupied by government and villagers private plantations, which have been surrounded by bamboo clusters and commonly scattered trees (Pookajorn 1977, 1979, 1984, 1986, 1988). In this region, most of the caves are in hills of Carboniferous and Permian limestone.

During 1977 to 1979, archaeologists of the Hoabinhian Research Project from Silpakorn University, led by Pookajorn, explored at Khao Talu, Ment and Heap caves near Ban Kao village. In the Khao Talu cave, they found three chambers, and one of these chambers had always been disturbed by villagers. Pookajorn (1977) excavated these chambers. The chamber 1 was in the entrance of the cave, and most of the surface was markedly littered with abundant waste flakes and cobble tools. It was called “Industrial area.” The chamber 2 was called “Hoabinhian area”, the artefacts were occurring on the surface with largest number of potsherds. The last chamber was frequently involved by human bones and potsherds that had been disturbed on the surface by villagers. This chamber was called “Burial area” (Pookajorn 1977, 1979, 1984, 1986, 1988).

The Kao Talu and Heap caves contained deposits up to 2 meters deep. The radiocarbon dates processed from twenty six samples provided ages ranging from 11,000 to 2000 B.P (Pookajorn 1984, 1986, 1988). The Ment cave is 30 meters to the north of Khao Talu. This cave was excavated by Pookajorn’s team in 1979, and had been divided into four chambers. An alidade was utilized for making the three- dimensional record of the artifacts, abundantly discovered in the cave (Pookajorn 1977: 120-121, 1984, 1986, 1988). Besides, the chronological and cultural sequences of Khao Talu, Ment and Heap Caves can be summarized into three cultural levels as following (from bottom to top):

Cultural levels	**Characteristic of the archaeological materials**	**Date (B.P)**
Cultural level I (Early Hoabinhian Technocomplex)	- Discovery of archaeological remains like cobble tools, flakes, animal bones, charcoal and seeds. - The majority of the cobble tools have been classified into 6 types. 1). Massive high-domed scrapers, with nearly the same thickness as length, unifacially worked. Most of them were similar to the Patjitanian tools of Java. 2). Large choppers (unifacial) with some remaining cortex. 3). Flat scrapers (unifacial) had been used on one edge. Some side scrapers shaped like bifacial handaxes, made from chalcedony. 4). Rounded oval hammer stones. 5). Sharp pointed picks with cortex on butt, presumably for digging or punching. 6). Pointed tools, different from the picks, with some flaking on both edges near the point	Layer 5 (Khao Talu), KTC-A1, OAEP-058, 9530 ± 1050 B.P Layer 4 (Khao Talu), KTC-A1, OAEP-056, 7530 ± 530 B.P Layer 7 (Heap), HC I-B2, OAEP-233, 8740 ± 470 B.P

	- Cobble tools and flakes made with quite simple techniques. Most of them were short axes and hammerstones. - Animal bones like turtle and shell remains found nearby in the swamps, along with fresh water pearls. - Broken bones were heavily broken in order to extract the marrow. - Seed and plant remains like *Beniesa arifera* of the Cucubitanace family and nut palm (*Licuala*) of the Palmae or Palmaecae family were found in considerable amount in this cultural level.	Layer 4 (Heap), HC I-A2, OAEP-158, 6350 ± 570 B.P
Cultural level II (Late Hoabinhian)	- Archaeological materials were discovered such as cobble tools “Hoabinhian Technocomplex”, flakes, waste flakes, animal bones (charred and uncharred), seeds, lumps of charcoal and potsherds of Ban Kao culture type. - The cobble tools had been classified into 3 more types, besides the ones already exposed in the cultural level I. 1). Short axes (unifacial); these tools have straight top edge, and the edges were regularly retouched out around the front side. 2). Oval shaped, flat, long unifacial tool. 3). Cleavers (unifacial), flat, the edges were retouched out from all around the front side. - Animal bones like turtles, frogs and crocodiles were largely exposed and similar to those in cultural level I. - The potsherds were recovered, but they might be belonged to cultural level III.	- Layer 3 (Khao Talu), KTC-A1, OAEP-107, 4520 ± 430 B.P - Layer 4 (Heap), HC I-B2, OAEP-154, 4350 ± 400 B.P
Cultural level III	- The potsherds of Ban Kao black polished type were associated with teeth, seed remains, especially rice grains (*Oriza sativa*) and beads in large quantity. - Human skulls, beads, polished stone axes, black polished potsherds and floral remains were discovered in the disturbed area of Khao Talu cave. - A large number of pebble tools and wasted flakes, including carbonized bones, shells were prominently abundant in this cultural level. - Beads, made of different kinds of stones as well as baked clay with slip.	- Layer 2 (Khao Talu), KTC-A1, OAEP-053, 3420 ± 380 B.P Layer 2 (Heap), HC I-B2, OAEP-152, 3200 ± 370 B.P

Cultural level I: the date of stone artefacts from this culture was estimated by Pookajorn (1986), to date around 10,000- 4500 years B.P. This culture started from late Hoabinhian to early Hoabinhian of the late Pleistocene to early Holocene. Comparison of the stone tools from Ban Kao site with other Hoabinhian sites from Southeast Asia, showed that most of the cobbles tools quite resembled artefacts in several caves in Vietnam (Tan 1979: 127-197; Pookajorn 1986, 1988), Sai Yok cave (Heekeren 1962; Heekeren & Knuth 1967), and Spirit Cave (Gorman 1970: 81, 1971b, 1972) in Thailand. The stone artefacts from Khao Talu, Ment and Heap caves were congruous with the stone tools that were found in Gua Cha and Gua Kechil caves in Malaysia, and with Northeast Indonesia (Heekeren 1957, 1972; Adi 1983; Aid 1985; Dunn 1964, 1966, 1970; Pookajorn 1984, 1986, 1988).

Cultural level II: it corresponds to late Hoabinhian, dated around 4500- 3500 years B.P. This cultural level was well known for the potteries of Ban Kao Neolithic tradition, perhaps associated with the Hoabinhian assemblages. SØrensen and Hatting (1967) attributed the Bang and Lue sites to the Neolithic period, when they compared the full range of archaeological materials, behavior and subsistence represented there to the cultural level II at Khao Talu, Ment and Heap cave (Pookajorn 1986, 1988; Pyramarn 1989; Shoocongdej 1996, 2000).

Cultural level III: the transition of the late Neolithic to the Bronze Age level gave a date around 2500-2000 years B.P. Also, the potsherds were found associated with the human teeth. Seed remains (Pyramarn 1989) and beads were discovered in quite large quantity. All the archaeological remains from this area consisted of human skulls, a polished stone axe, beads, black polished potshards of Ban Kao type and botanical remains; they were assigned to the late Neolithic to early Metal age (Pookajorn 1986, 1988; Shoocongdej 1996, 2000).

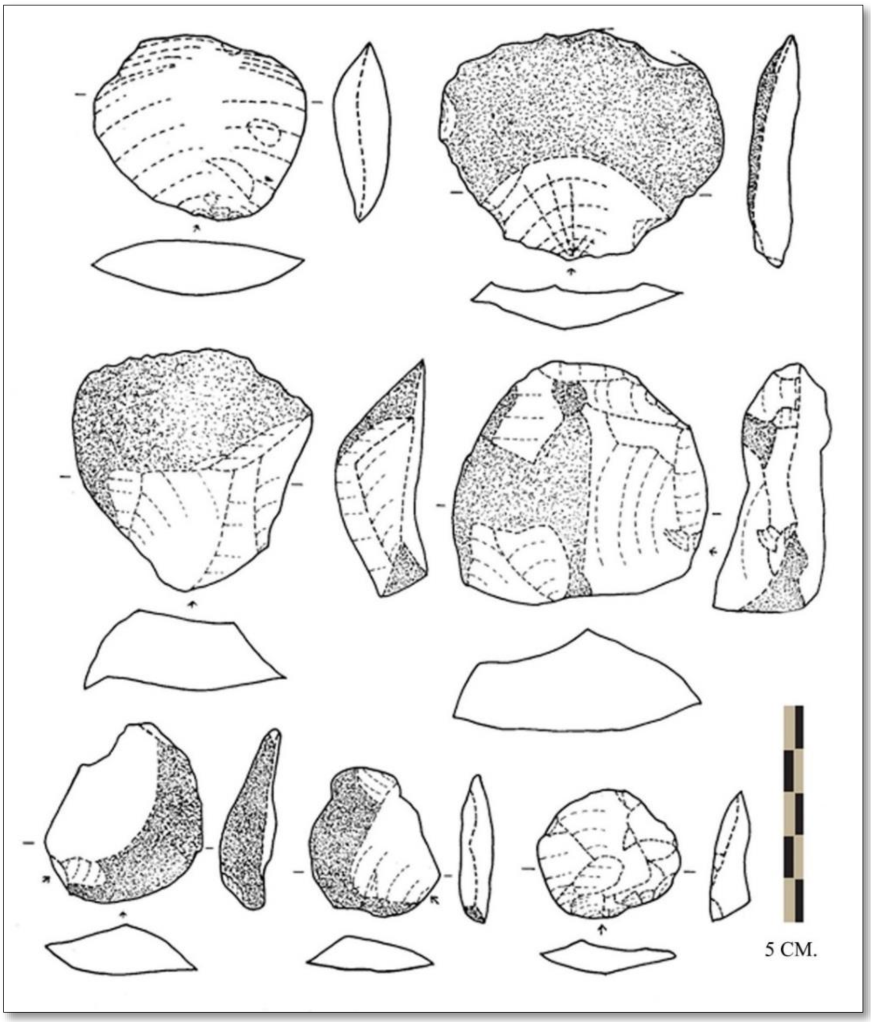


Figure 1.3.14 Stone artefacts from Ban Kao sites, Western Thailand (Source: Pookajorn 1988)

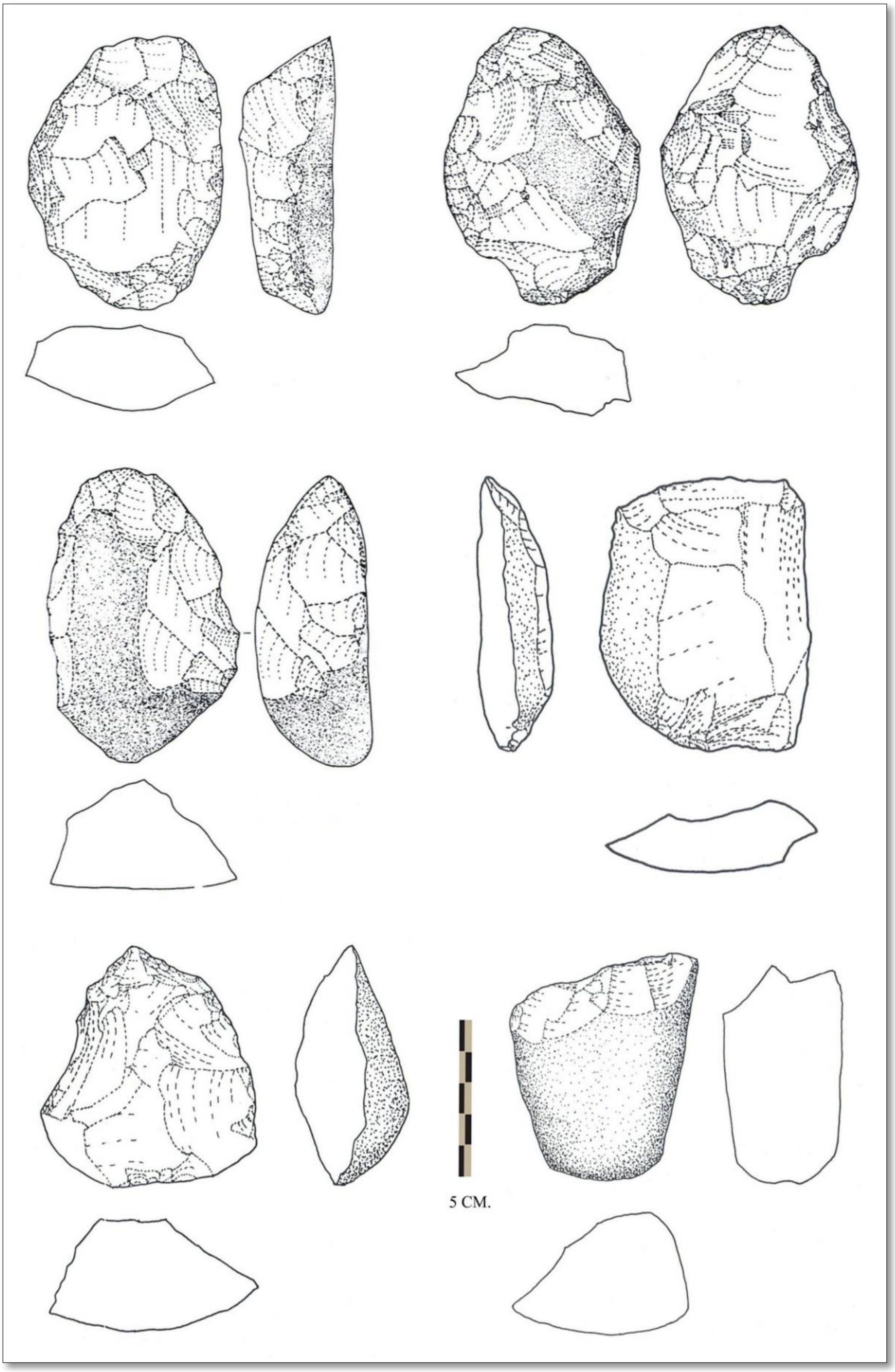


Figure 1.3.15 Stone artefacts from Ban Kao sites, Western Thailand (Source: Pookajorn 1988)

No.	Square	Specimens	Layer	Radiocarbon date (B.P.)	Range, 1SD	Range, 2SD	Cultural level
1	KTC-A1	OAEP 104	I	2800 ± 300	3100 - 2500	3400 - 2200	Cultural lever III
2	KTC-A1	OAEP 053	II	3420 ± 3800	3809 - 3040	4100 - 2660	
3	KTC-A1	OAEP 054	III	4215 ± 95	4310 - 4120	4405 - 4025	Cultural level II (Late Hoabinhian)
4	KTC-A1	OAEP 107	III	4520 ± 430	4950 - 4090	5380 - 3660	
5	KTC-A1	OAEP 054	IV	5100 ± 500	5600 - 4600	6100 - 4100	Cultural level I (Early Hoabinhian Technocomplex)
6	KTC-A1	OAEP 107	IV	5700 ± 700	6340 - 4940	7040 - 4240	
7	KTC-A1	OAEP 054	IV	7640 ± 700	6400 - 5000	7100 - 4300	
8	KTC-A1	OAEP 107	IV	7535 ± 850	8200 - 6500	9050 - 5650	
9	KTC-A1	OAEP 054	IV	7530 ± 530	8380 - 6680	8910 - 6150	
10	KTC-A1	OAEP 107	V	8400 ± 640	8920 - 7680	9560 -7040	
11	KTC-A1	OAEP 054	V	8300 ± 620	9040 - 7760	9660 - 7140	
12	KTC-A1	OAEP 107	V	9790 ± 750	9540 - 8040	10290 - 7290	
13	KTC-A1	OAEP 054	V	9450 ± 1050	10500 - 8400	11560 - 7350	
14	KTC-A1	OAEP 107	V	9980 ± 530	10510 - 9450	11040 - 8920	
15	KTC-A1	OAEP 054	V	9530 ± 1050	10580 - 8480	11630 - 7430	

Table 1.3.8 Radiocarbon Results from Khao Talu Cave; Ban Kao, Kanchanaburi Province, Western Thailand (Source: Pookajorn 1988)

No.	Square	Specimens	Layer	Radiocarbon date (B.P)	Range, 1SD	Range, 2SD	Cultural level
1	HC -I-A1	OAEP 149	I	2150 ± 300	2450 - 1850	2750 - 1550	Cultural lever III
2	HC-I- A2	OAEP 150	Ib	2070 ± 360	2430 - 1710	2790 - 1350	
3	HC-I- A2	OAEP 152	II	3200 ± 370	3570 - 2830	3940 - 2460	
4	HC-I-B2	OAEP 153	III	4100 ± 300	4420 - 3780	4140 - 3460	Cultural level II (Late Hoabinhian)
5	HC-I-B2	OAEP 154	III	4350 ± 400	4750 - 3950	5150 - 3550	
6	HC-I-B2	OAEP 155	IV	5200 ± 380	5580 - 4820	5960 - 4440	Cultural level I (Early Hoabinhian Technocomplex)
7	HC-I-A2	OAEP 156	V	5600 ± 450	6050 - 5150	6500 - 4700	
8	HC-II-T1	OAEP 157	IV	6050 ± 500	6550 - 5550	7050 - 5050	
9	HC-I- A2	OAEP 158	IV	6350 ± 570	6920 - 5780	7490 - 5210	
10	HC-I-B2	OAEP 111	VII	8200 ± 500	8700 - 7700	9200 - 7200	
11	HC-I-B2	OAEP 233	VII	8740 ± 470	9210 - 8270	9680 -7800	

** OAEP= Office of Atomic Energy of peace of Thailand,
** + Radiocarbon determination base on half-life of 5730 years.

Table 1.3.9 Radiocarbon Results from Heap Cave; Ban Kao, Kanchanaburi Province, Western Thailand (Source: Pookajorn 1988)

1.3.10 Tham Phaa Chan

The site of Tham Phaa Chan (also known as Steep Cliff cave) is a small limestone cliff shelter, located about 2 kilometers north of the Pai River in Mae Hong Son province, North-western Thailand. The radiocarbon dates on charcoal between 7500 ± 160 years B.P (GaK-4531) and 5180 ± 110 years B.P (GaK-4530) were uncalibrated (White and Gorman 1979). Tham Phaa Chan yielded a large amount of flakes and debris, in addition to almost 200 cobbles and some grinding stones. This site, along with two other sites excavated by Chester Gorman, Spirit cave and Banyan valley cave, was the first Hoabinhian excavation to employ screening (Gorman 1971b, White and Gorman 1979, 2004; Bannanurag 1988).

The butchered remains were recovered from Tham Phaa Chan, along with some spectrum assemblage remains, where they found in different from Spirit cave and Banyan Velley cave (Higham 1977; Gorman 1971). They suggested that the cobble tools and sumatraliths, which were more prominent among the Tham Phaa Chan lithic artefacts, in comparison with those other two sites, were in some way parts of the Hoabinhian butchering tool kit (White and Gorman 2004; Marwick 2007, 2008). Besides, the raw materials of the stone assemblage were water worn river cobbles, and the majority of them in quartzite might have been acquired from the stream bed of the Pai River. The water worn quartzite cobbles were usually flaked unifacially along all or the major part of their periphery, probably gaving strength to the unifacially flaked edge (White and Gorman 1979, 2004).

White and Gorman (2004) sampled 417 flakes for analysis, regarding metric and non-metric attributes. They wanted information about each stage in the manufacturing process, about the flaked cobble (Marwick 2007, 2008). Therefore, their basic method notably proved that the Hoabinhian technology of Tham Phaa Chan was based on systematic and differentiated flake removals, for instance, the result showed the presence of dorsal step flakes, which were influenced by flake height and flaking angle. Then, the utilization of Hoabinhian flakes should be explored, when more sophisticated function analyses were done on Hoabinhian industries (White and Gorman 2004; Marwick 2007, 2008).

Activity Set	**Product Groups**	
	Implements:	*Debitage:*
Selection of raw materials	Unmodified water worn cobbles	
Decortication	Cobbles freshly flaked around periphery (unifacial)	Flakes with a substantial amount of cortex on dorsal surface and striking platform.
Edge Use	Unifacially flaked cobbles with damaged edge (micro-flaking)	Tiny chips and flakes unlikely to be recovered
Edge Trimming	Cobbles with a series of step-flake scars along flaked edge	Small thin flakes with damaged dorsal angle, distal steep fracture, cortical striking platform.

Edge Shaping	(see edge trimming above)	Flake with cortical striking platform, undamaged dorsal angle, no dorsal step-flake scars, but with dorsal angle unsuitable for use.
Edge Rejuvenation	Reduced cobbles with large fresh flake scars on flaked face	Large flakes with step-flake scars on dorsal surface, edge damage on dorsal angle.
Bifacial Flake Removal	Cobbles with bifacial flake scars	Large flakes with cortical dorsal surface, non-cortical possibly micro-flaked striking platform.
Dorsal Cortex Removal	Cobbles with dorsal cortex removed	Flakes with cortex centered on dorsal surface, or at the distal end, non-cortical striking platform, probably obtuse dorsal angle.

Table 1.3.10 The hypothetical lithic reduction model for Tham Phaa Chan, activity set sequence proposed for typical Hoabinhian cobble tools (Source: White and Gorman 2004)

Consequently, the Hoabinhian in terms of an industry (rather than a culture or technology as primarily admitted) will help to meaningfully delineate a temporal and geographical range. The flakes were produced to re-sharpen the cobble tools rather than to be used as flake tools, because the authors believed the average size of flake was too small for using (White and Gorman 2004).

Bannanurag (1988) worked on the stone artefacts from Tham Phaa Chan cave. Actually, she studied, for her Master thesis, the steep-angled edges, microscopic polished and micro-flake scars by usewear analysis. As a result, the stone artefacts were used for working wood and bone, rather than meat or soft vegetable matter. However, this work didn’t present the comparison with experimental material, and it was a very small sample for the analysis: only 28 cobble tools from Tham Phaa Chan cave had been analysed.

White and Gorman (2004) laid their study at Tham Phaa Chan on the theoretical and quantitative framework of three stages in the Hoabinhian reduction sequence: (1) the systematic selection of locally available raw materials, namely somewhat flat, oval quartzite river cobbles, and continuing with (2) the cobbles’ systematic modification by flaking beginning with initial shaping by unifacial and circumferential decortications, and followed by (3) various differentiated shaping and resharpening activities, repeated as needed throughout the tool’s use-life (with the majority of flakes struck circumferentially from a single cortical surface). On this basis they concluded that their study supports the consideration of the Hoabinhian as an industry.

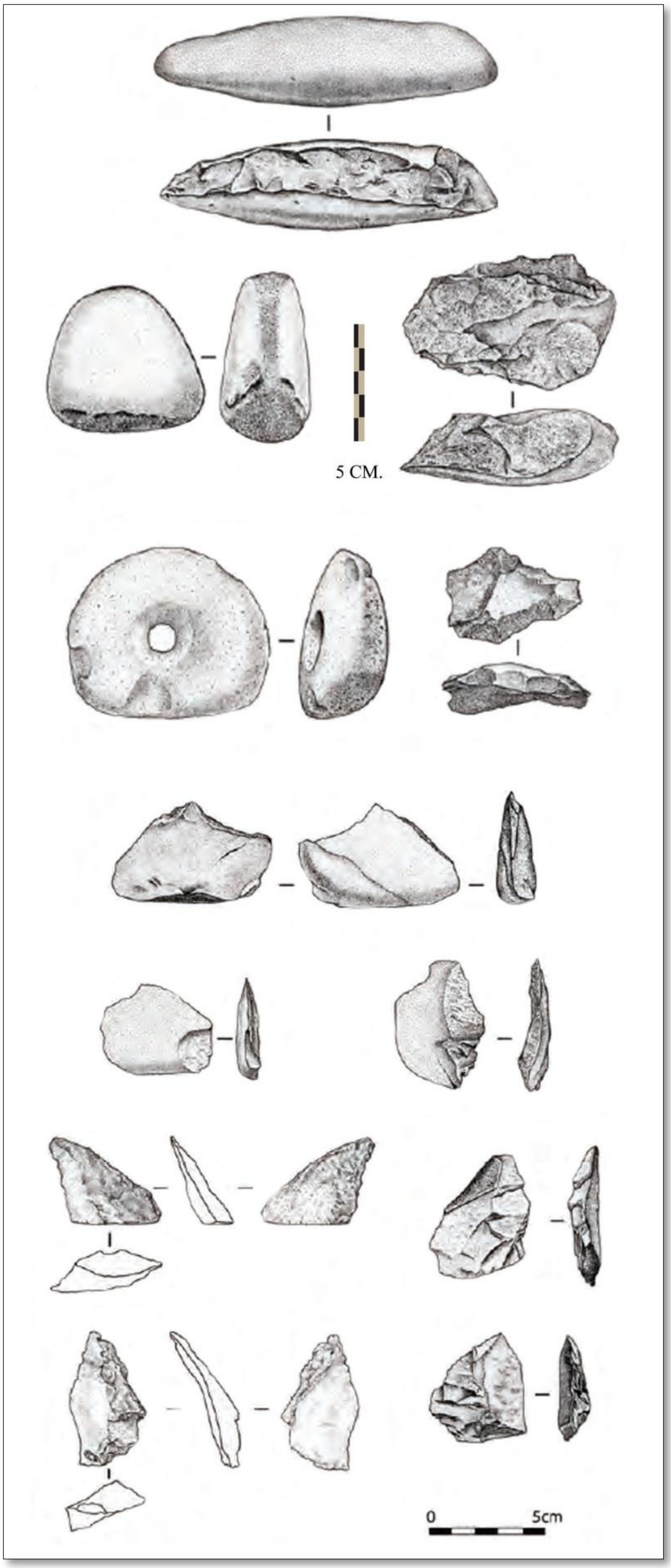


Figure 1.3.16 Stone artefacts from Tham Phaa Chan sites, North-western Thailand (Source: White and Gorman 2004)

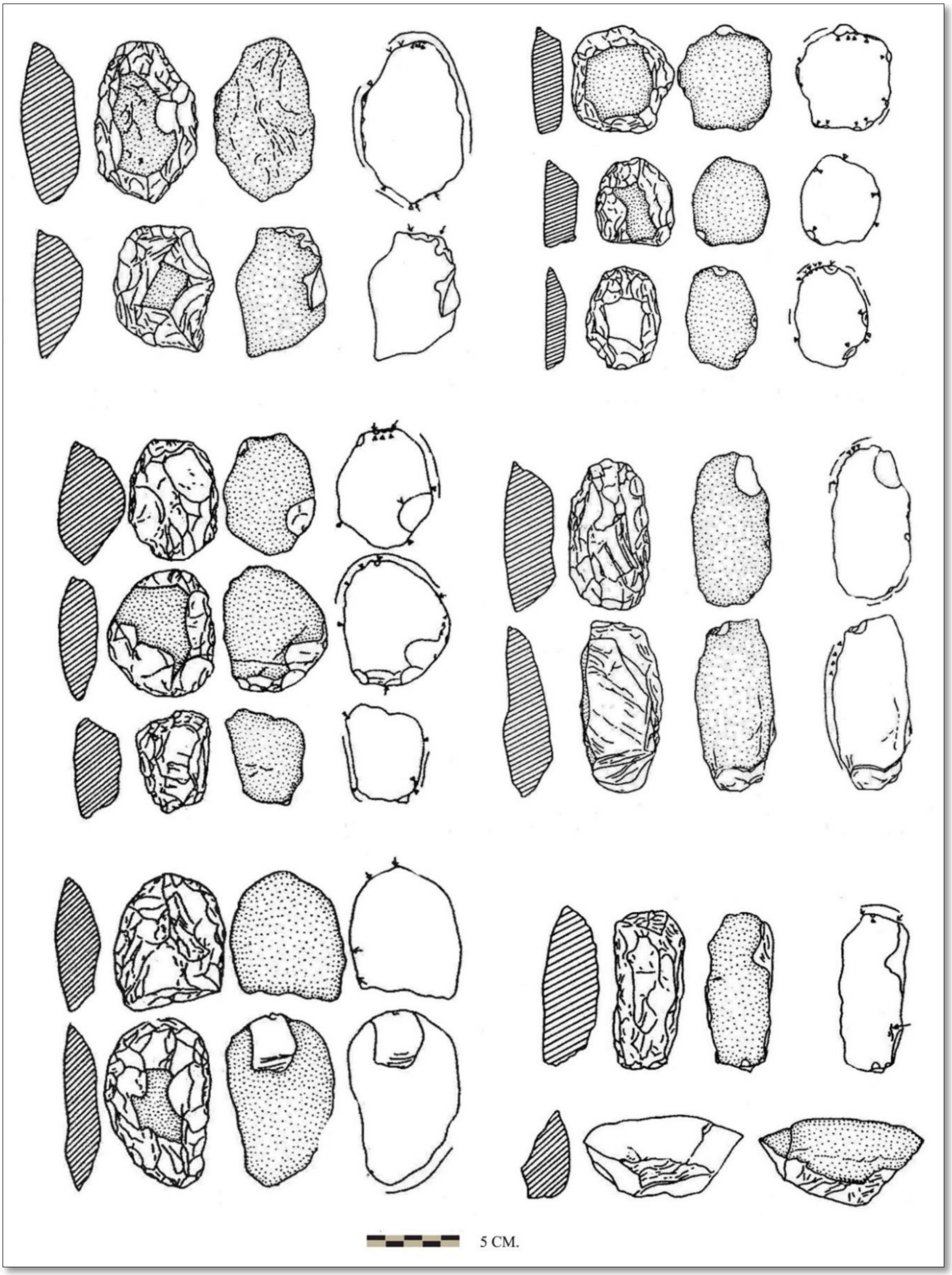


Figure 1.3.17 Stone artefacts from Tham Phaa Chan sites, North-western Thailand (Source: Bannanurag 1988)

1.3.11 Tham Khao Khi Chan

Tham Khao Khi Chan is a cave in Surat Thani Province, Southern Thailand. In 1985, Tharapong Srisuchat and members of the Fine Art Departments excavated the site for a part of salvage project. The cave of Tham Khao Khi Chan is situated at 70 meters above sea level, overlooking a valley floor at 45-50 meters above sea level. Two trenches were opened in the site and the depth of the deposit was approximately 2.60 meters. Reynolds (1989) had given the details about dates of assemblages such as bones and charcoals, but laboratory dates (presumably uncalibrated) were 4760 ± 150 B.P, 5090 ± 120 B.P, 5620 ± 200 B.P, and 6070 ± 170 B.P. The radiocarbon dates were officially processed by the Thai Office of Atomic Energy for Peace (OAEP).

The totality of five habitation layers was excavated at Tham Khao Khi Chan, and it was not possible to separate out the assemblages from habitation layers 2 to 4, because of the convoluted stratigraphy and excavation by spits (Reynolds 1989). The Tham Khao Khi Chan is characterized by the poor quality of raw materials such as quartz, quartzite and siliceous shale. They have always been present in Southeast Asian industries, but some quartzites occurring in this site appeared to be of good quality (Reynolds 1989). The artefact classes, present in each of these layers, had to set out in different categories. For example, the category of “axes” was added for a number of pieces of uncertain function, bearing bifacially stepped-back flaking. If this flaking was not the result of deliberate retouch, then these tools could have served as hammers. Even though, this was often difficult to determine (Reynolds 1989).

According to Reynolds (1989), the highlight of his study was that he created subclasses of flake forms in term of percentage of dorsal cortex. It was particularly useful for “Hoabinhian” when he argued that the retention of cortex was a major consideration. This clearly was the case for the steep-edged pieces. Also, he separated the flakes into retouched, utilized and plain categories.

Stone artefacts	**Characteristic of the lithic materials**
Flakes	- The majority of flakes in Hoabinhian assemblages showed utilization that was not produced on flakes, but on core tools, i.e., the utilized flakes were re-sharpening pieces. - Frequencies of plain and retouched flakes at Tham Khao Khi Chan argued against this view, because damage usually occurred on the flake edges that would not have been exposed to wear on the cores or core tools. - Crushing of edges of the steep-edged pieces and platforms of the flakes is the product of use or technology. - Using of a relatively heavy hammer (as it was common at Tham Khao Khi Chan) upon flattish cobbles resting on the ground could have produced the edge crushing and shattering, probably removing numerous small splinters as well as larger flakes. - This “unclean” removal process also resulted in steep-fracturing of the flakes as they were coming away from core. - In general terms, the tertiary flakes outnumber the primary ones, but they are not to such a degree as to suggest intensive reduction. - Flakes dominating over core tools and steep-edged pieces remain the most recognizable feature of the industry.

Hoabinhian tools	- The employed class list served to identify the “Hoabinhian” nature of the industry at Tham Khao Khi Chan through the frequencies of the steep-edged pieces, with their “cortex retaining properties”. - The class list was not specifically designed to identify the Hoabinhian, but it is possible to identify it from some artefacts in which the frequencies of step-edged pieces are high unifacial patterns. - The inclusion of broken pieces allowed for the demonstration that materials were either heavily used or of poor quality (possibly a combination of both). - Re-using of broken pieces, as illustrated by the frequencies of retouched and utilized debris, was not important because of the poor quality raw materials. - It was difficult to decide, whether the pieces were retouched or utilized before or after breakage. - The ratio of core tools to retouched and utilized flakes really provided an indication.

Therefore, flakes dominating over core tools and steep-edged remains, is the most recognizable feature of the industry. None of the changes were sufficient to warrant separating out the assemblages in the different habitation layers. It is interesting that even when the frequency of better raw materials increased, there was no related increase in the finer tool forms.

According to Reynolds (1989), in his conclusion, the stone industry at Tham Khao Khi Chan cave appeared to be a fairly typical Hoabinhian for southern Thailand, with many steep-edged core tools, retouched in such a way as to retain cortex adjacent to the flakes edge. Flakes were an important part of the assemblages, both technologically and functionally. The flakes rather suitable for use were selected from a range, whereas resharpening of flakes was rare (Reynolds 1989: 42). In this pattern, and elsewhere in Southeast Asia, particularly at Niah Cave (Malaysia), Majid Zuraina (1982) also classified the stone tools as heavy-duty and light duty tools. This distinction was worth being made, because it ordinarily corrected old views of Southeast Asia industries as a “chopper-chopping tool” complex. In fact, in any Thai studied assemblages, there wasn’t any true example of a chopping tool. There were not bi-products from the manufacture of core tools, because of the retouched and utilized examples (Reynolds 1989).

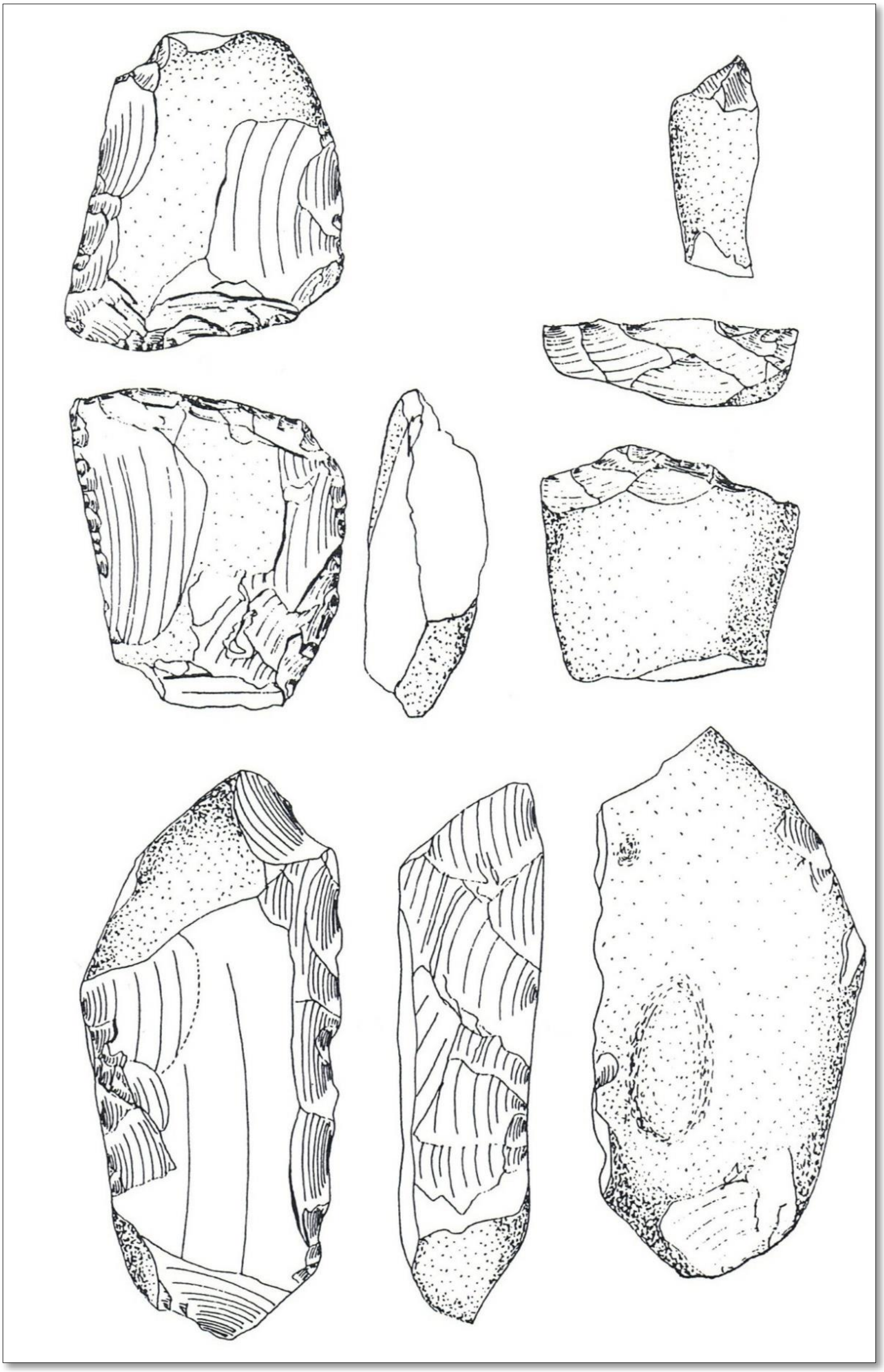


Figure 1.3.18 Stone artefacts from sites Tham Khao Khi Chan, Southern Thailand (Source: Reynolds 1989), 60% of natural size

1.3.12 Banyan Valley Cave

The site of Banyan Valley cave lies some 50 meters above a small stream near Ban Mai Hang Village, Mae Hong Son province, North-western Thailand. This site was discovered in 1972 during general survey work, led by Gorman (Reynolds 1992). The surveys in northern Thailand recognized many more sites such as Steep Cliff cave and Banyan Valley cave. Later, Gorman excavated these caves. Generally, the caves were similar in terms of both cultural materials and cultural sequences to Spirit cave, although Banyan Valley Cave also yielded a unique bifacially worked, tanged point (Gorman 1972, 1977; Reynolds 1992). The excavation resulted in the formulation of a hypothesis that the Hoabinhian economic sequence, in this region of Southeast Asia**,** commonly showed a trend toward the development of agriculture (Gorman 1972, 1977; Yen 1977; Reynolds 1992). The site of Banyan valley was considered younger than Spirit Cave on the typological grounds and assemblages (lithic and ceramic).

A total of ten pits of 4 m^2 each were excavated at Banyan Valley cave. The site was complex, with much disturbance in the archaeological materials, packed into a relatively limited depth of deposit. Gorman (1972) used a series of general levels because the stratigraphy was outstandingly confused. Therefore, from the excavation, the first general level was the surface throughout in the lower level (level 3: GL 3).

According to Reynolds (1992), the results of the analysis were noticeably different between GL1 and GL2, with materials from GL2 and below having a clear Hoabinhian character. Lithic assemblages of Banyan Valley rather lacked the cobble tools, and most of flakes were quite thinner and less stepped on dorsal surfaces (Reynolds 1992).

Cultural sequence	**Characteristic of the lithic assemblages**	**Date (B.P.)**
GL1 (Metal Age)	- Polished stone adze, a flaked quadrangular adze, the bifacially flaked and tanged projectile point came all from GL1 or above. - A series of chips and bladelets, presumably from a ground quadrangular adze, occurred in GL 1 and above, but the adzes themselves, or rather the worked-out remnant of them, were not found. -No deliberate or systematic manufacture of blades or bladelets, which was identified, and all cores were rather informal. - Cortical and plain platforms dominated the platform types, but crushed platforms also occurred with some frequency.	GL1 (Gak-4340), from square F4, 930 ± 80 B.P (A.D. 1020, using the 5570 half-life).
GL2, GL3 (Early Hoabinhian)	- All attributed technology from the Hoabinhian industry (GL2 and GL3) showed hard-hammer, direct percussion using relatively heavy hammers. - Shatter and crushing commonly occurred, while occasional flakes with double bulbs of percussion were also present.	GL2, (Gak-4341), from square D4, 5360 ± 120 B.P (3410 B.C.) (Neither date has been calibrated)

	- Frequency, the double- bulbed and Siret flakes of non-Hoabinhian was lower, but it was similar between raw materials that had been used. - The finer grained raw material was most common in the Hoabinhian levels. - Hoabinhian industry contained sumatraliths (unifacially flaked discoids), short axes, steep-edged pieces and axes. They are characteristic of the “Hoabinhian technocomplex” in Thailand. - These, occurring in low frequencies, were lacking in the overlying levels. - A single flake with the broken off bulb was recovered from the Hoabinhian level GL2. - A single fragment of an edge-ground slate knife was exposed from the Hoabinhian-associated deposit GL2, and a few pieces came from GL1. - A single fragment related to Bacsonian was discovered in levels associated with the Hoabinhian, but not clearly attributable to either GL2 or GL3. - A fragment with two grooves smoothed along it, running parallel down its main axis was also found. - An artefact could have served for polishing small stone tools, for grinding the edges of slate knives, or for smoothing wooden or bone tools. - One final stone artefact that should be noted is a water-worn sandstone cobble with two parallel black lines on one side.	

The dates at Banyan Valley cave have been obtained by radiocarbon and thermoluminescence methods. According to Reynolds (1992), these estimates suggested that occupation within GL2 dated to 3410-2000 B.C., whereas GL1 falls within the last millennium B.C. and the first millennium A.D., and no stratigraphic hiatus was visible between the two general levels. In addition, the date of occupations in GL3 presumably was earlier than 3000 B.C., but there it was given the thickness of deposit, the similarity in materials between GL2 and GL3. The date of GL3 should be much older than 4000 B.C.

As a result, Banyan Valley cave showed two distinct phases of occupation: an early Hoabinhian one, with cobble tools, large number of flakes, and broad-spectrum exploitation of plants and animals; and a second one, in which the Hoabinhian cobble tools were absent (Gorman 1972, 1977; Reynolds 1992). New tool forms occurred such as ground lenticular, quadrangular adzes and tanged points. Besides, the second occupational phase associated with the later edge-ground slate knives, compared with rice reapers, came from this level. The single one fragment was infrequently accepted in GL2. The Hoabinhian lithic complex at Banyan Valley cave was associated with pottery in GL2, both cord-marked and plain (Gorman 1972, 1977; Reynolds 1992).

In addition, the single iron fragment also found in GL1; so this phase could be Metal Age. Therefore, Banyan Valley cave is greatly important to showing a sequence from the Hoabinhian to what is the Metal Age in northern Thailand (Reynolds 1992).

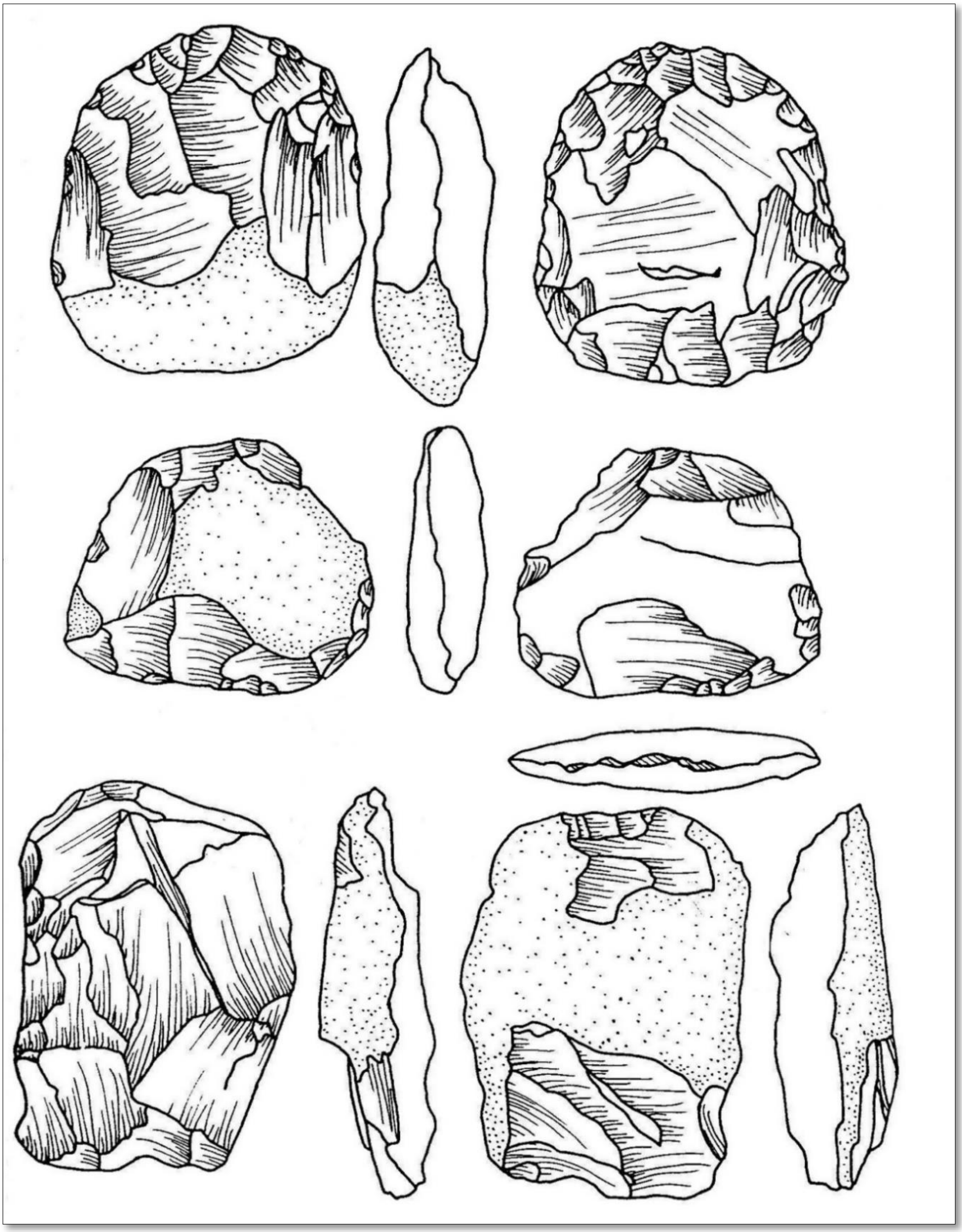


Figure 1.3.19 Stone artefacts from Banyan Valley cave, North-western Thailand (Source: Reynolds 1992), no scale in original

YEARS B.P.	MOH KHIEW ROCKSHELTER	LANG RONG RIEN ROCKSHELTER	KHAO TALU AND HEAP CAVES	ONGBAH CAVE	LANG KAMNAN CAVE	SPIRIT CAVE	BANYAN VALLEY CAVE	THAM PHAA CHAN CAVE	THAM LOD ROCKSHELTER
	Adze/Pottery	Adze/Axe blade /Pottery/ Hoabinhian	Pottery/Short Axes/Hoabinhian	Metal age (Iron/Bronze?)	Pottery/Flakes?		Adzes/ Flakes/ Hoabinhian		Pottery/Flakes/ Core tools
5,000 —						Flakes/Adzes/ Pottery/ Hoabinhian		Flakes/Cobble tools (Hoabinhian)	
	Blank Axes				Flakes/Core tools (Hoabinhian)				
		Bifacial tools/ Hoabinhian/ Flakes	Cobble tools (Hoabinhian)	(Hoabinhian?)					
10,000 —				(Hoabinhian?)		Flakes/Grinding stones/ Hoabinhian			
	Cobble/Flake tools								
					Flakes/Stone fragments				Flakes/ Short Axes/ Core tools /Choppers/ (Hoabinhian)
20,000 —									
	Flake tools	Flake tools			Small flakes, Core tools				
30,000 —									Flakes/ Core tools (Choppers)
		Flake tools/ Core tools							
40,000 —									

Table 1.3.11 Time-wise distribution of stone assemblage characteristics from prehistoric sites in Thailand

1.4 Chronological sequence of prehistoric sites in Thailand, during Late Pleistocene to Early Holocene

In the major part of the XXth century there was no concrete chronological sequence for the Prehistory of Thailand and no fixed chronological sequence for the artefact assemblages, possibly due to the lack of reliable dates in well-developed stratigraphical sequences in Thailand and Southeast Asia. The terminologies and concepts of Thai (and Southeast Asian) prehistory have been defined by native and foreign scholars since the1960s. According to Prishanchit, Bronson and Natapintu (1988), when a new form of the archaeological sites and industries is discovered, it becomes rather difficult to place the archaeological material in a time framework due to undefined typo-technology and chronological framework. The new discoveries often served to underline the difficulties of the existing archaeological foundation. However, researchers have continued to excavate prehistoric sites (Natapintu, 1988, 1991; Pookajorn 1991, 1994, 2001; Shoocongdej 1996, 2001, 2002, 2003, 2007; Auetrakulvit 1995, 2004, Auetrakuvit et al. 2012), which significantly improved the chronological framework. They have also developed the concept of technical analysis in order to classify the prehistoric material in terms of techno-typology. These are important contributions to our understanding and interpretations of artefacts and assemblages, recovered from surveys and excavations.

Formerly, the chronological sequences of Thai (and Southeast Asian) prehistoric sites referred to the simple sequence of Palaeolithic (Chopper-Chopping tool period), Mesolithic (Hoabinhian), Neolithic through Metal age, and was prominently accepted in the 1960s by English archaeologists. Later, Bronson and Charoenwongsa (1988) used systematic archaeological research methods in Thailand. The study of the sites by using new techniques provided a few dates on the late Pleistocene sites in Thailand and led to determine that assemblages were from late Pleistocene to Holocene time period. On this basis, Bronson and Charoenwongsa (1988) worked out the sketch of the current state of knowledge. It was regarded as the chronological framework of culture development in Thailand (and Southeast Asia) during the prehistoric period (Bronson and Charoenwongsa1988). The cultural development has been detailed in the diagram below and could serve as reference to some prehistoric sites.

The chronological sequence started from the late Lower / early Middle Pleistocene, considering the artefact assemblage comprising cobble tools discovered by SØrensen (1976) at Ban Mae Tha in Lampang province (Bronson and Charoenwongsa 1988). After that, the late Pleistocene was represented by the early flake tools, followed by Proto-Hoabinhian / Cobble tools for example from Lang Rongrien Rockshelter in Krabi province (Anderson 1986, 1988, 1990). Lastly, the Holocene period was divided according to the presence or absence of pottery within the archaeological material into Pre-pottery Hoabinhian and Hoabinhian with pottery, and then by the occurrence of flaked adzes, these three phase being followed by the Neolithic (Ongbah cave, Ban Khao sites, Sai Yok, in Kanchanaburi province: Sørensen 1988; Pookajorn 1977, 1979, 1984, 1988; van Heekeren and Knuth 1967: Spirit cave, Tham Phaa Chan and Banyan Valley, in Mae Hong Son province: Gorman 1970, 1971b, 1972; White and Gorman 1979, 2004, Bannanurag 1988; Reynolds 1992). At the end, they separated the artefacts in different phases, between the Bronze Age and Iron Age (Ongbah cave, Sørensen 1973, 1988, Ban Don Tha Phet, Sørensen 1974; Gorman 1976, Ban Non Chai, Non Pa Koi, Ban Chiang Hein, Pimai sites, Chan san site, Khoa Wong Prachan sites and Ban Pong Manao etc., Bronson, Charoenwongsa and Natapintu 1988; Shoocongdej 1996).

The diagram of Bronson and Charoenwongsa (1988) is different from the pre-1960 scheme. Some archaeologists disagreed with the details as the diagram was more complex than it was formerly believed in the 1960s and they continued to refer to the pre-1960 scheme. However, Bronson and Charoenwongsa (1988) continued to believe in their diagram that was close to the current consensus (**figure 1.4.2**).

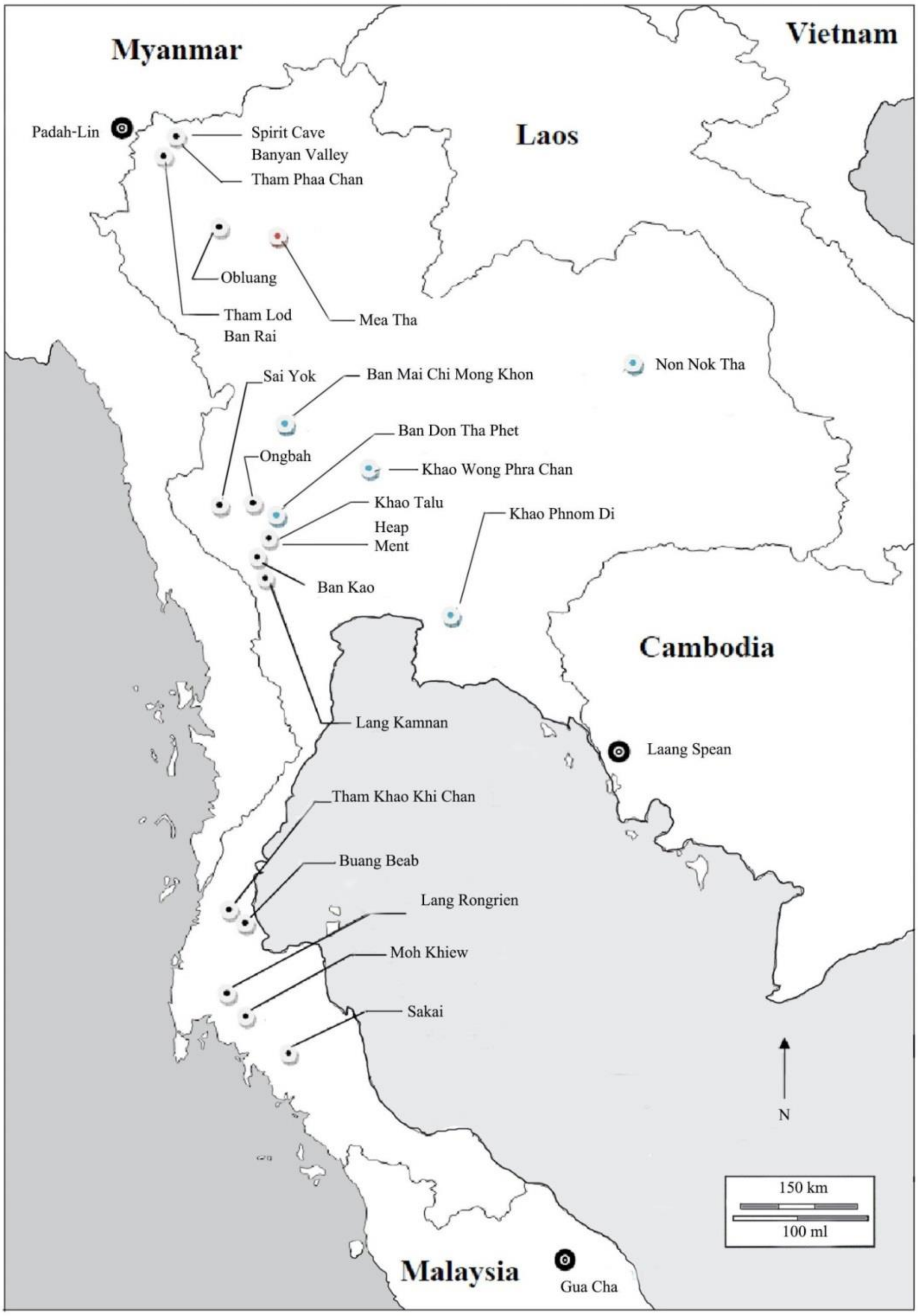


Figure 1.4.1 Map showing approximate locations of some prehistoric sites mentioned in text

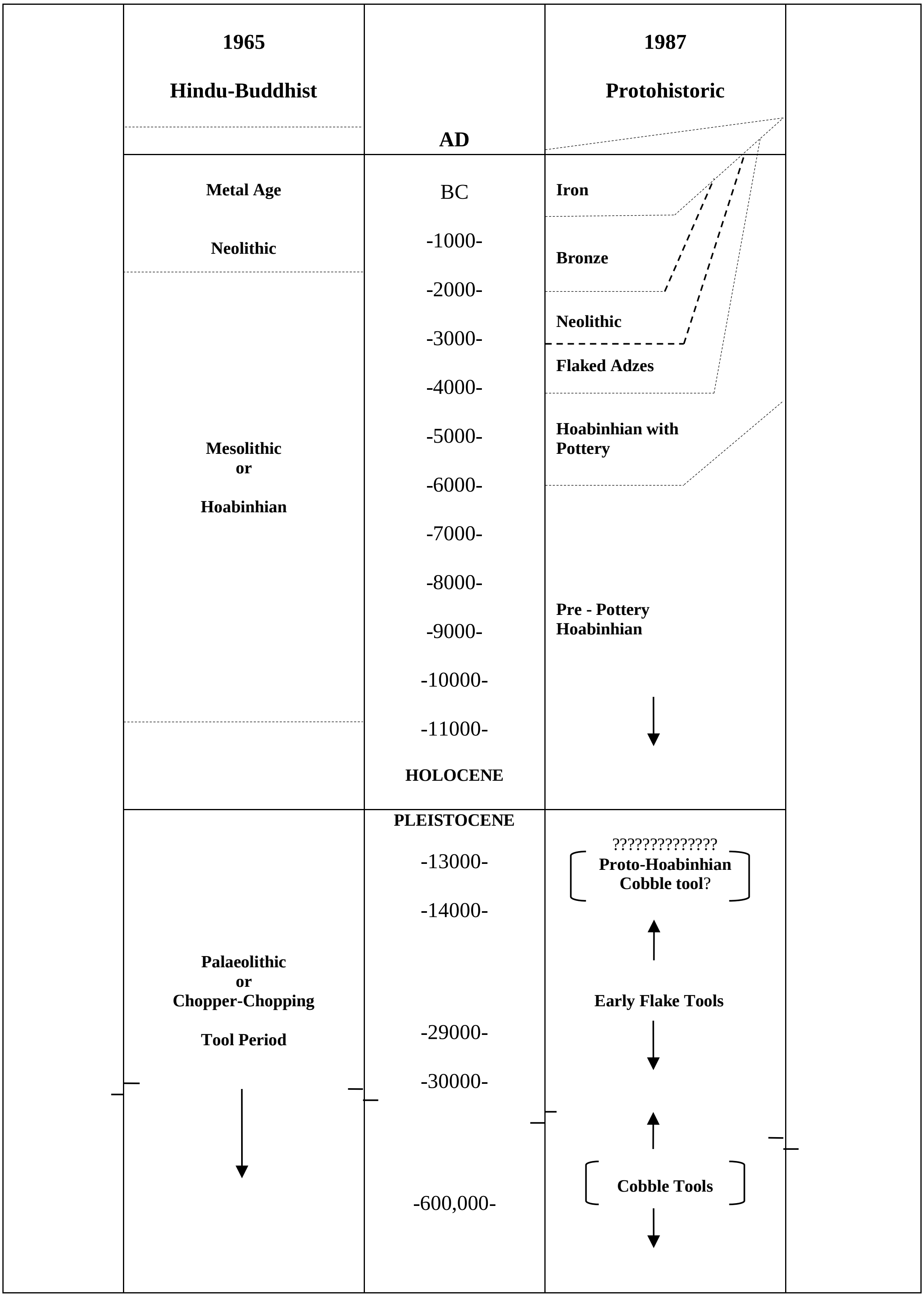


Figure 1.4.2 Two chronological sequences of Thai prehistory, *Left*: The traditionally accepted sequence as of ca. 1965. *Right*: The sequence as revised in the light of recent research (Source: Bronson and Charoenwongsa 1988)

The chronological scheme can be used as a framework in seeking explanations for the variability in the archaeological record. It can help in understanding the cultural history, apparently based on socio-economic development.

In this dissertation, an attempt has been made to build a techno-cultural sequence for the prehistory of Thailand based on lithic assemblages, mainly late Pleistocene to early Holocene period. This sequence is supported by radiometric dates and connected with a geological timescale. Consequently, to avoid the problems of cultural sequences between times and spaces, tentative dates of the artefact assemblages from previous excavations have been scrutinized. The new chronological scheme of Thai prehistory is based on the results of research conducted at different sites during the last two decades. This new view is open for discussion and revision based on the new dates of archaeological remains in the future.

In Thailand, the earliest Pleistocene period is just a little known. Sørensen (1976) and Pope (1978) explored a site at Ban Mae Tha in Lampang province. They found cores or pebble tools in fluviatile deposits, underlying a basalt flow (the Lampang basalt). These artefacts are in sandstone or in well indurated conglomerate (Pope et al. 1981). The basalt from the fluviatile deposit was generally flowed and it is possible that the finding was not a definite artefact (Allen 1991). In contrast, Sørensen (1976) and Pope (1981) suggested that the cobble tools or “chopper-chopping tools” could certainly be very early. In fact, it might be early or actual tools (Charoenwongsa 1987, 1988). The date of the basalt material at Ban Mae Tha was a minimum around 690,000 B.P (Charoenwongsa 1988). Recent work in this area did not confirm the occurrence of artefacts below the basalt flow but resulted in the collections of many choppers above it (Zeitoun et al. 2013).

The Late Pleistocene: The stone artefacts were largely developed in this period, especially at Lang Rongrien Rockshelter (in Krabi province; Anderson 1986, 1988, 1990). The flake tools are found in more numbers than core tools in this period, however the flake tools and core tools are quite similar to tools of early Holocene. It was considerably older than other late Pleistocene sites in Thailand with radiocarbon dates of 37,000 ± 1780 B.P.

Tham Chang Rockshelter (Obluang site in Chiang Mai province: Santoni et al. 1985, 1986, 1990) seemed rather homogenous in stone artefacts. The flake tools were mostly retouched flakes, which were proportionally less than core tools. The types of core tools are scrapers, cleavers, pointed, notched and denticulated tools. The occupation did not cover a very large area, but it might have lasted quite long. This site evidenced single culture period, which had been dated to 28,000 B.P., from a fragment of burnt bone.

A few flake tools only were present in the early period (26,580 ± 250 B.P) of Moh Khiew Rockshelter (in Krabi province; Pookajorn 1991, 1994, 2001, Moser 2001). Generally, in the later periods the stone assemblages were well represented by flake tools and core tools, dated by radiocarbon method (25,800 ± 600 B.P). More than 60 per cent of the flake tools were presumably used. The unifacial tools were rather small in size, and seemed quite multi-purpose in form and function. The flake tools of late Pleistocene were more similar to those of the roughly contemporary assemblages, found at Tabon Cave in Philippines, Niah Cave in Sarawak, Nguom and Mieng Ho in Vietnam (Bronson and Charoenwongsa 1988).

The stone assemblage of Lang Kamnan cave (in Kanchanaburi province; Shoocongdej 1996, 1996a, 1996b, 2000) included small flakes, core tools and fragments. The artefacts were basically dominated by flakes, besides a few unutilized flakes and core tools, but flake tools were absent. The radiocarbon dating was around 26,920 ± 600 B.P.

For the late Pleistocene (35,782 ± 266 B.P) and early Holocene (11,550 ± 40 B.P) periods, Tham Lod Rockshelter (Shoocongdej 2001, 2002, 2003, 2004, 2005, 2006, 2007; Khaewkamput 2003; Khaokhiew 2003, 2004; Amphansri 2004, 2005, 2011; Pureepatpong 2004, 2006; Kheawtaya 2005; Wattanapituksakul 2006) is well known for its rich faunal and lithic material. The stone artefacts comprised of fragments, flakes, small tools and core tools, made from complete cobbles, broken cobbles or split cobbles. Several types of core tools such as choppers, sumatraliths, partly unifacial or bifacial cobble tools, were discovered in all the layers along with a few smaller tools on flake or fragment, especially scrapers. Most of core tools are characterized by unifacial shaping and manufactured by free-hand percussion by a hard hammer stone. These assemblages illustrate the technological and morphological evolution of the stone tools in the late Pleistocene and early Holocene (Chitkament et al. 2015). Many datations have been processed on different materials and with different methods.

The boundary of Pleistocene and Holocene: The prehistoric sites in Thailand (and Southeast Asia) have significantly shown various types of lithic assemblage, abundantly and continuingly used in the cultural sequences up to the middle Holocene. It seems there is no significant change in the assemblages at the boundary Pleistocene-Holocene in Southeast Asia. For instance, in the site of Tham Lod Rockshelter, the stratigraphic sequence of area 3 provided a radiocarbon date of 12,100 ± 60 B.P. This layer is very rich in archaeological materials, especially of stone artefacts belonging to Hoabinhian tradition, largely related to faunal, floral and freshwater shellfish remains during the Pleistocene to the Holocene boundary period.

Early Holocene: Radiocarbon dates, ranging in early Holocene, were obtained from many prehistoric sites in Thailand (Pookajorn 1977, 1979, 1984, 1986; Shoocongdej 1996, 1996a, 1996b, 2000; Auetrakulvit 2004, 2006; Treerayapiwat 2005). The most significant dates for Hoabinhian tools were based on the radiometric dates from the oldest occupation of Ongbah cave (Sørensen 1988; Kanchanaburi province), and Spirit Cave (Gorman 1970, 1971b, 1972: Mae Hong Son province). It is to be noted that the earliest dates for Hoabinhian are not in the early Holocene. The cultures of Ongbah cave were represented by lithic assemblages, mostly made from cobbles (Sørensen 1988), which were knapped into flakes, utilized cores, choppers and scrapers. Gorman (1970) believed that there might be an earlier Hoabinhian phase without edge-grinding in Thailand because there was the presence of an edge-grinding in the Hoabinhian tools at Spirit Cave.

Recently, Ban Rai Rockshelters (Shoocongdej 2000, 2001, 2003, 2007; Pureepatpong 2004; 2006; Treerayapiwat 2005 in Mae Hong Son province) radically help to know more about the early Holocene in Thailand. The stone artefacts notably provide older dates than 11,000 B.P and some radiometric samples had also been dated older than 10,000 B.P (Treerayapiwat 2005). Therefore, Ban Rai Rockshelter is the highlight one of the Hoabinhian culture because the archeological remains have been contributed to understand the human activity and cultural changes during the late Pleistocene through to the late Holocene period.

CHAPTER II

Presentation of Tham Lod Rockshelter and excavation materials in Highland Pang Mapha, Mae Hong Son Province, North-western Thailand

2.1 Geographical outline of Northern Thailand

Northern Thailand (Northwestern Thailand or the Northwestern Highlands in certain literatures) is situated in the southern extension of the Shan mountain ranges, extending from 26º 41′ to 28º 21′ north and from 88º 45′ to 95º 10′ east **(figures 2.1.1 and 2.1.2)**. The concerned area comprises ten administrative provinces: Mae Hong Son, Chiang Mai, Lamphun, Lampang, Chiang Rai, Phayao, Nan, Uttaradit and the upper part of Tak. The region occupies an area approximately 107,510 sq km or 21% of the total country (Santisuk 1988: 11). There are multiple mountain ranges towards the Northern Thailand, mostly extending from the bordering Myanmar and Laos. Often these mountains are cut by rivers forming deep valleys. This mountainous topography is a part of a wide range of geomorphological landscapes which include high plateaus, foothills, lower hill ranges and lower plateaus.

Four mountain ranges are parallel to each other and are orientated in a north-south direction. The northwestern and western mountains are composed of the Daen Lao and Thanon Thong Chai ranges, forming a natural boundary along the frontier with Myanmar, and to the south, are connected with the Tanao-Si (Tenasserim) ranges, in Tak province. In the central area of the North is the smaller Phi Phan Nam range. These three ranges are in fact the southern extension of the Shan range of Myanmar. The eastern boundary with Laos is marked by the Luang Prang range, which represents the western extension of the Laos-Tonkin (North Vietnam) range (Santisuk 1988: 11).

The mountains in Northern Thailand are the sources of the three drainage basins. On the western border are the Pai and Yom Rivers in Mae Hong Son province. In Tak province, the Moei River drains into the Salween River of Myanmar. In the east, the Khok River in Chai Rai province and the Ing River in Phayao province flow northwards into Mae Khong River, on the Laotian border. The major drainage area consists of the Ping, Wang Yom and Nan Rivers running from the north to south between the ridges, forming Chao Praya River in the great central plain (Santisuk 1988: 11).

The northern hill rises to up to c.1600 m above the sea level, with numerous high peaks rising above 2200 m (Bangkok, B.E. 9th Pacific Science Congress 1957: 11; Gorman 1970, 1971b, 1972). These high mountains are evidently incised by steep river valleys and upland areas that border the central plain. The valley basins range from 150 to 380 m above sea level. The greatest part of irrigated rice cultivation fields of the northern Thai farmers is provided by the narrow alluvial plains, developed here and there along the basins. Three main types of rock groups are discovered in northern Thailand: Upper Permian to Triassic or the Lampang group, Silurian-Devonian to Lower Carboniferous or Tanaosi group and the gneiss and schist of Pre-Permian. These groups have been identified and classified by mineral and chemical composition (Pookajorn 1985, 1986, 1988).

According to Baum et al. (1970), the largest part of the western mountains is covered with rocks of the Silurian-Devonian and Carboniferous age, characterized by calcareous-shaly sedimentation and sandy-shaly- cherty facies. There are conspicuous north-south bands of the Triassic granites, plus small outcrops of Carboniferous and Permian limestones. A series of Triassic sedimentary and metamorphic rocks occur along the western border between Mae Hong Son and Mae Sariang districts (Braun & Hahn 1976; Santisuk 1988: 12). The eastern mountains are dominated by Permo-Triassic and Cretaceous or Upper Triassic conglomerate and sandstone sediments. The narrow north-south bands of Triassic limestones are encountered between Chiang Rai and Lampang (Braun & Hahn 1976; Santisuk 1988: 12). A small series of Permo-Triassic volcanic rocks of andesite, rhyolite and tuff occur in the northeastern part of the North Thailand (Chiang Rai- Chiang Khong), whilst the ophiolite, andesite and tuff of Carboniferous age are very sporadic in the Northern Highlands. In the valley basins, Quaternary-Tertiary alluvium and terrace deposits are common (Braun & Hahn 1976; Santisuk 1988: 12).

Therefore, the Northern Thailand, like the rest of the country, is influenced by the monsoon climate, characterized by the remarkable alternation of the hot dry season and rainy season. The high altitude and latitude are marked with pronounced seasonal temperature variations, especially the cooler winters than in the other regions. Generally, the mean relative humidity ranges from 60 per cent in the dry season to 80 per cent in the rainy season. The annual rainfall, temperature and relative humidity are practically related to elevation.

Figure 2.1.1 Map of Thailand, showing northern Thailand, and the location of the Mae Hong Son province (Source: www.doh.mot.go.th)

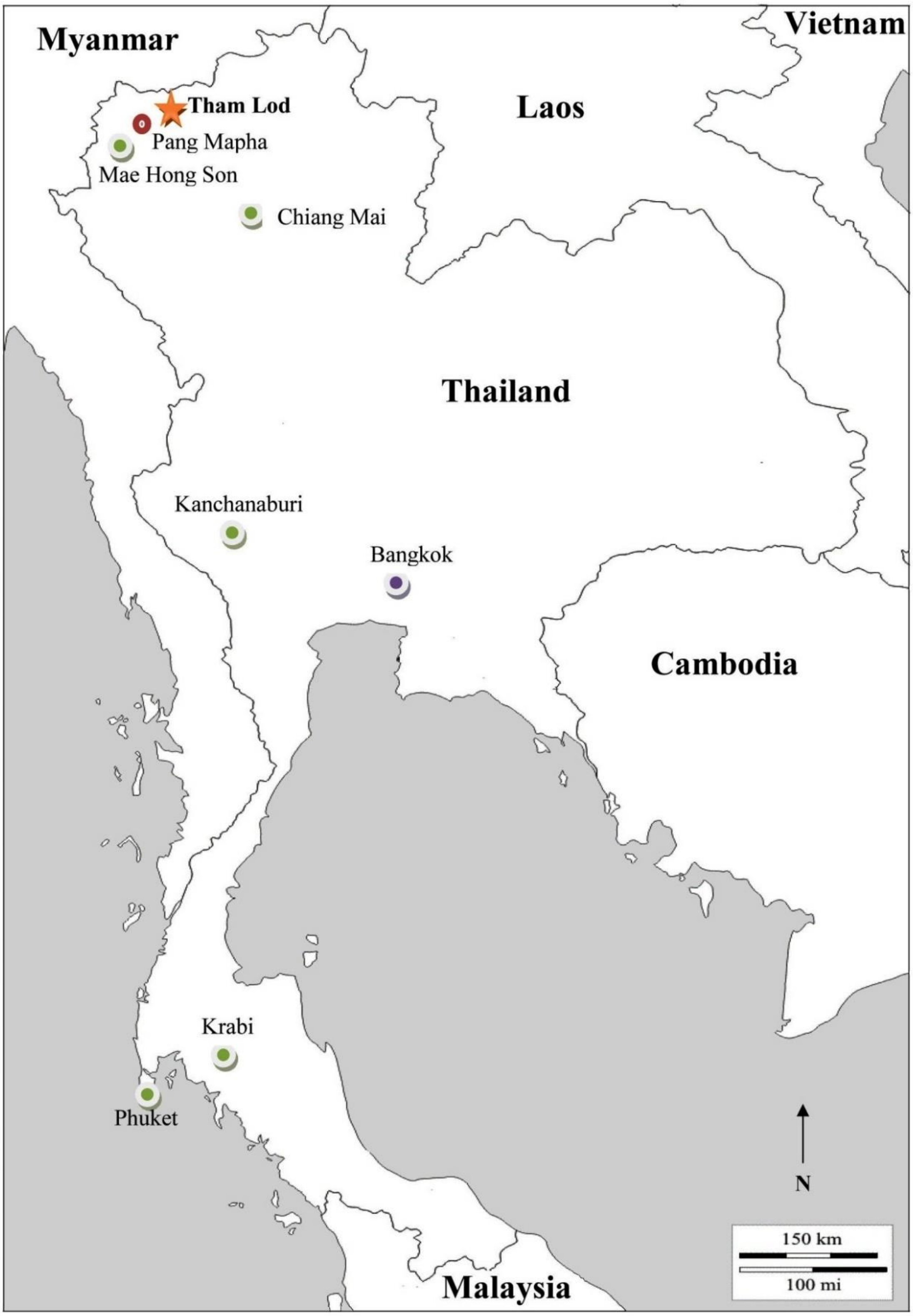


Figure 2.1.2 Map of Southeast Asia, showing Thailand and the location of the main cities near Tham Lod in Mae Hong Son province

2.2 Geographical and environmental setting (Mae Hong Son province)

The research area is located at the latitude 17° 38′ to 19° 48′ north and longitude 97° 20′ to 98° 39′ east in Mae Hong Son province. This province was formerly called “Mae Rong Son”. It is approximately 900 km north from Bangkok. It is delimited by natural and political boundaries, and covers an area of 13,814 sq km. The neighboring provinces are (from north clockwise) Shan State of Myanmar, Chiang Mai and Tak provinces. To the north and west, it is connected to three states of Myanmar, namely the southern portion of the Shan state, Kayak state and Kawthoolei state; to the south, to the district of Tha Song Yang, in Tak province; to the east, to the district of Wiang Haeng, Chuang Dao, Mae Teang, Mae Cheam, Hot and Omkoi, in Chang Mai province. The region of Mae Hong Son is principally situated in the Shan hills, near the border with Myanmar, along the banks of the River Pai, and every district of the region shares a common border with Myanmar as well as with the Shan state.

Mae Hong Son is a complex and rugged mountain range of the Thai highland. For example, the Daen Lao range, located on the northernmost portion of the province, marks the north boundary between Thailand and Myanmar, as the Dawna range marks the west boundary. The Thanon Thongchai range, in the east of the province, apparently serves as boundary between the province of Mae Hong Son and Chiang Mai. The tallest point of Doi Mae Ya is located towards the northeast of the province at c. 2005 m above sea level. Some parts of the province are still covered with rain forest and almost 88 % of this constitutes pristine virgin forest.

The environment of this area is rather changed by hill tribes. The forest mountain and savanna are partially created by short and long-lasting shifting of cultivation, and are found on the high plateaus and hills in the northern Thailand. Also, the yields of crops are really low due to soil erosion and poor physical and chemical properties. Most of the highland erosion occurs during the rainy season. The eroded sediments have been filled up to the stream channels. The red-yellow podzolic soils on residuum and colluviums came from acid rocks (Pookajorn 1985, 1988). The soil is covered by mixed deciduous forest, dipterocarp forest and dry evergreen forest. Therefore, a part of the region is cleared by the shifting cultivation.

The lithology and structure of carbonates are of same age as that of the Sino-Burma Mountain (Kiernan 1991b; Marwick 2008). As a result of the uplift, the Permian limestone karst rises up to 1000 m above the valley floors. This is possibly a representation of the ancient erosion surface of Permian epoch, especially at around 1100 m (Marwick 2008). In contrast, the scenic karstic landscapes, characterized by steep limestone hills with exposed, barren, craggy rides, are present in Mae Hong Son, Chiang Mai, Lampang, Phayao, Nan and Tak provinces (Santisuk 1988:11). The most notable is the limestone massif (350-2175 m) of Chiang Dao district, Chang Mai province.

Also, the drainage in the karst systems has determined the formation of extant caves and rockshelters, as evolution of underground streams and sinkholes. The drainage is mostly underground as the evolved and eroded landscape shows it. Numerous deep caves and cliffs have become exposed, and have hanging parts above the valley’s floor. This drainage is very extensive, with the region containing two of the most extensive underground cave systems known in mainland Southeast Asia (Richardson 2003; Khaokhiew 2003, 2004; Marwick 2008: 124).

2.2.1 Recent Climate and Seasonality

The climate of Mae Hong Son region is monsoonal climate, characterized by the noticeable variation between hot dry and rainy seasons. Three seasonal periods could be identified in this region: cool and dry from November to February, hot and dry from March to May, and warm and wet from May to October. The detailed climate records for Pang Mapha region are not available, but a weather station in the district capital at Mae Hong Son has collected temperature and rainfall data since 1951. According to Richardson (2003), the average annual rainfall in Mae Hong Son is 1277 mm, but might be closer to 2000 mm. In the monsoon season of Pang Mapha, the rainfall is around 90% between May and October (Richardson 2003; Wattanapituksakul 2006; Marwick 2008).

The mountainous region of Pang Mapha has heavier rainfalls which mostly spread over a long period, than in lower altitude areas. The heavy rain starts in May and lasts until October and the average rainfall in August is around 253 mm. Between November and April, there is little rain (Dept. of Meteorology 1982a).

According to Marwick (2008), the annual temperature variations in Mae Hong Son are relatively narrow, from 29ºC in April to 21ºC in January. A better indication of the variability comes from the mean monthly maxima and minima. It is extreme and imposes limits on the bioproductivity. The temperature ranges from mean maxima of 36ºC in April to 28ºC in December, and mean minima of 24ºC in June and 14ºC in January. During the coldest months, the temperature in Highland Pang Mapha region frequently falls below 10ºC and even soil frost has been reported (Richardson 2003; Marwick 2008: 126). Furthermore, the temperatures are high throughout the year, and the average temperature is around 22ºC from November to April. The temperature is gradually rising and reaches peaks in April at a monthly average of 26º C. Nowadays, the climate of Mae Hong Son province is fairly cool with moderate humidity (Wattanapituksakul 2006).

1) Recent Forests: vegetation resources

Type forests	Contexts	Floral species
1)Mixed deciduous forest	- This forest type found in highland Pang Mapha is dense occurs in areas of abundant water availability, at 300 - 900 m above sea level. - The richness of species in this forest is moderate.	- The distinctive floral species: *Tectona grandis* (teak), *Shorea obtuse* (siamese sal), *Shorea siamensis*, *Xila xylocarpa*.
2) Dry dipterocarp forest	- This forest type sporadically overlaps with semi-evergreen forest in the upper ranges. It vastly extends towards almost 1000 m above sea level. - This forest is a low and open forest dominated by deciduous trees. The ranging is closed canopy of an open woodland structure. - The habitat is characterized by 5-7 dry months and 1000 - 1500 mm of rainfall, a slightly drier habitat than the lower semi-evergreen forests.	- The dominant species include *Dipterocarpus obtusifolius*, *Shorea optusa*, *Shorea siamensis*, the legumes *Xylia kerrii* and *Pterocarpus macrocarpus* (Rundel and Boonpragob 1995).

	- The bamboo is common in more open areas. - In the Lang River basin, the dry dipterocarp forest is profound at 1,100 m above sea level (the Remote Sensing and Geo - informatics System Center 1998).	
3) Hill evergreen forest	- This forest is somewhat taller than upper montane forest and is frequently richer in tree species, but poorer in epiphytes. - This type of forest appears from about 1000 m above sea level and is called "hill evergreen forest" or "lower montane pine - oak forest". - It is best developed along ridges and moderate to steep slopes at 1000 - 1400 m above sea level (Santisuk 1988).	- The distinctive floral species are *Pinus merkusii*, *Pinus kesiya*, *Quercus* sp. (oak) and *Castanosis* sp.
4) Semi - evergreen forest	- This type of lowland forest is known as "dry evergreen forest", "seasonal rain forest" or "mixed deciduous forest" and is composed of a mixture of a deciduous canopy trees and evergreen taxa in the canopy and lower stories (Santisuk 1988: 27, Marwick 2008: 130). - This kind of forest spreads at river bank of Lang River, which has rather high moisture content. - The vegetation is approximately located at 250-900 m above sea level. The habitat of these forests is characterized by about 5-6 dry months and 1400 - 1800 mm of rainfall. -The bamboo is relatively uncommon because it is not suited to limited light that penetrates canopy, so it only appears in open area (Wattanapituksakul 2006; Marwick 2008: 130).	-The evergreen dipterocarps, especially *Ditperocarpus turbinatus* etc., are recovered in this forest form.
5) Bamboo forest	- The family of bamboo (Poacea) repeatedly distributes in many kinds of forests: mixed deciduous forest, semi-evergreen forest and dry dipterocarp forest (Wattanapituksakul 2006). - Also, the bamboo forest frequently replaces the real trees forest and is a secondary forest after occurrence of the wild fire or cultivation.	- Most of bamboos can be found at Lang River basin like *Bambusa arudinacea*, *Bambusa nutas*, *Cephalostachyum pergracile*, *Cephalostachyum virtum*, *Dendrocalamus giganteus*, and *Dendrocalamus hamiltonii*.
6) Limestone forest	- The limestone forest is well developed at many localities throughout the country, what is forming the karst topography. There, karsts are almost devoid of soil and subject to extreme water stress. This forest is somewhat low in stature, except on basal screes, and with an even canopy (Parr J.W. 2003). - The majority of geological structure in the basin is calcium-rich, suitable condition to support a distinctive flora, rich in endemic ground herbs, some woody - leaved genera.	- There are distinctive xerophyte floral species (*Dracaena loureiri* and *Euphorbia* sp.), palms, grass and bamboo.

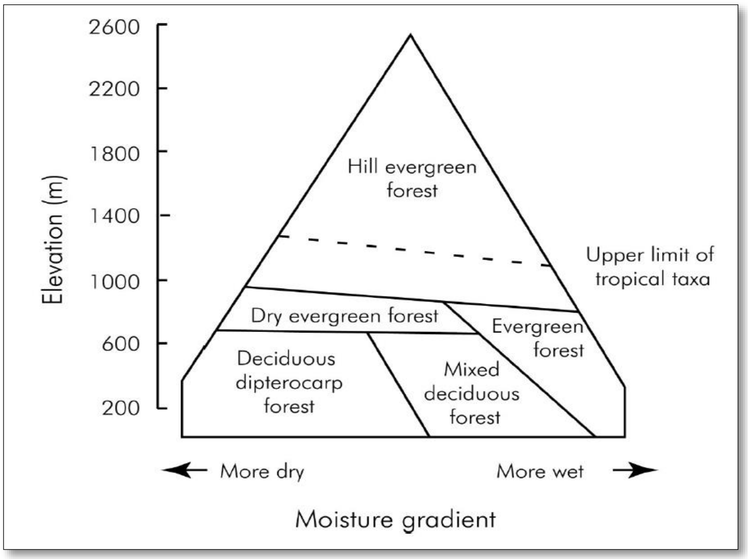


Figure 2.2.1 Schematic representation of the relationship between forest types, elevation and wetness in northern Thailand (Source: Marwick 2008: 147)

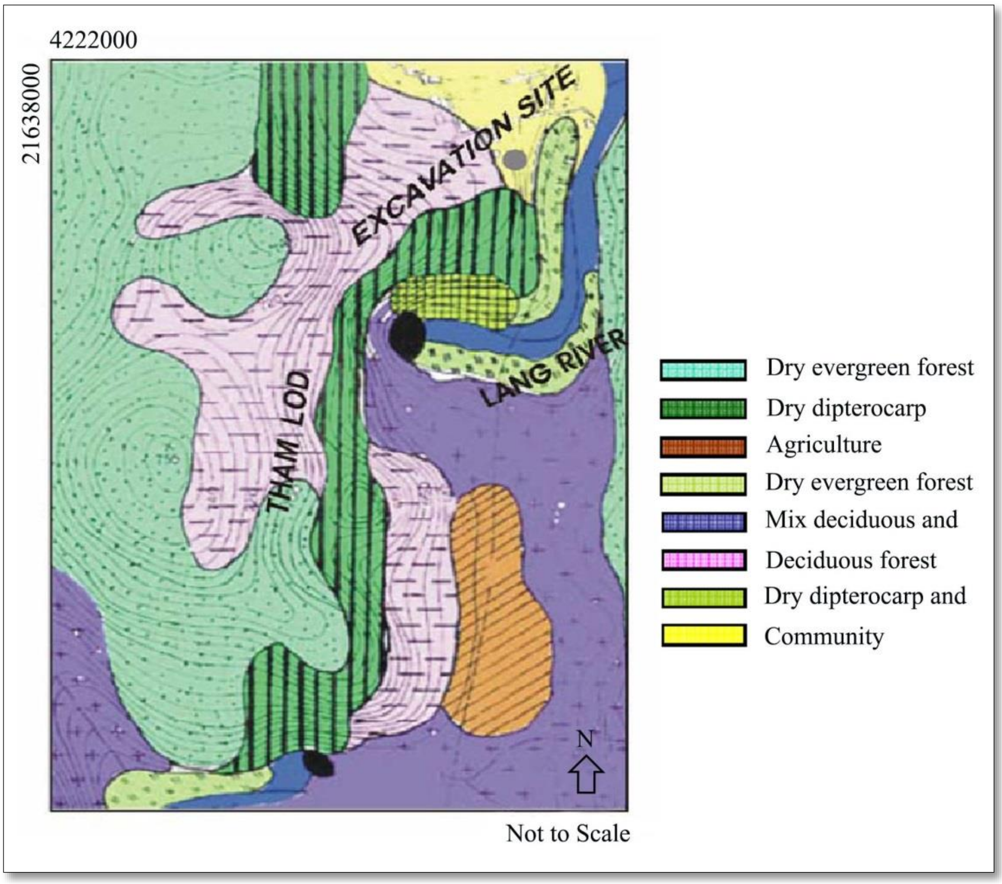


Figure 2.2.2 The habitat diversity in the study area, surrounding in the Tham Lod rockshelter (Source: Khaokhiew 2004)

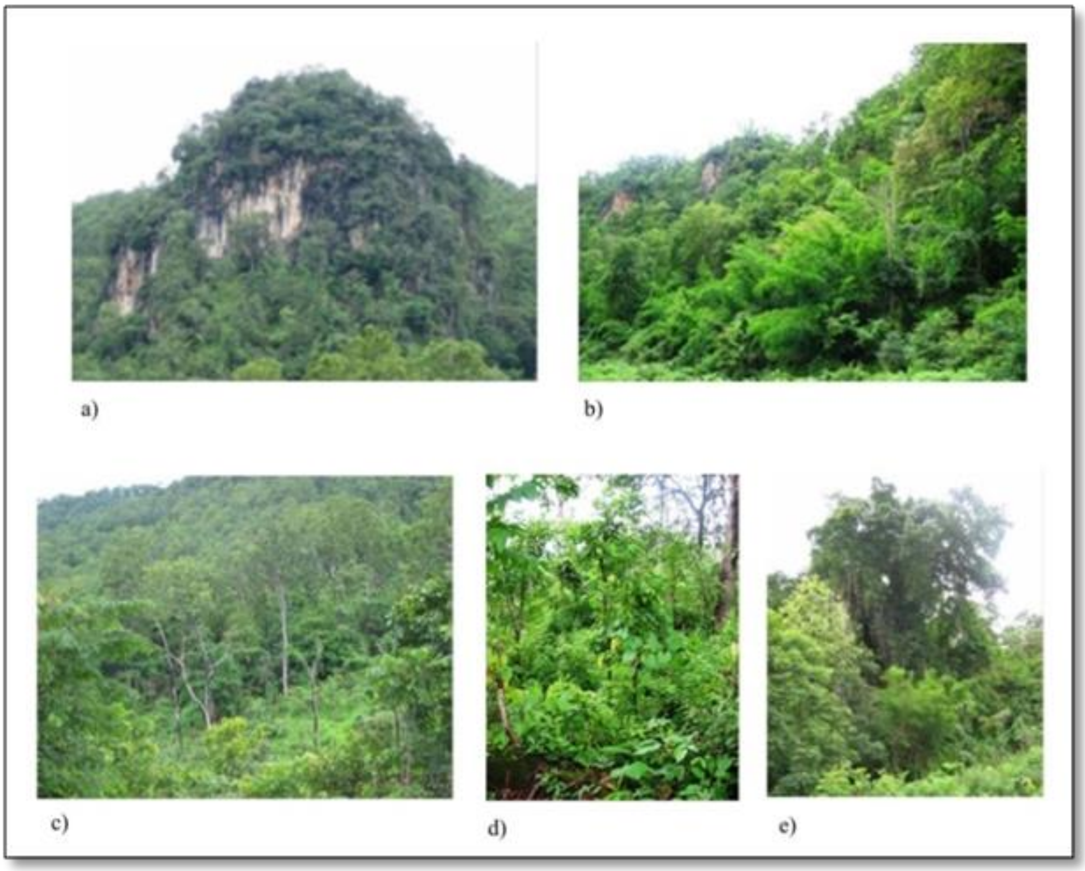


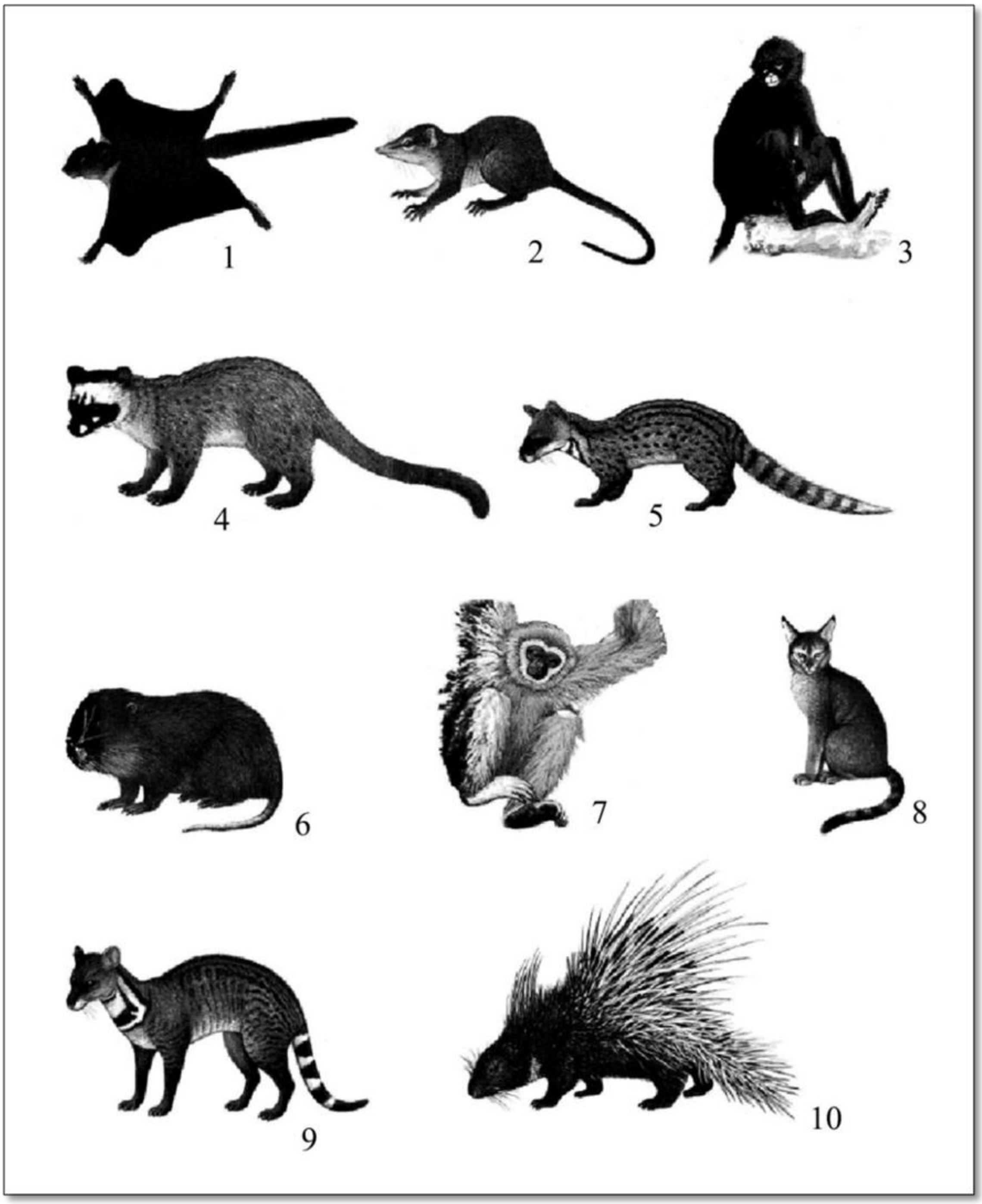
Figure 2.2.3 Recent forest in Ban Tham Lod: a) The limestone forest, dominated by *Dracaena loureiri*, *Euphorbia sp.*; b) The limestone forest mixing bamboo forest, showing *Dracaena loureiri*, *Euphorbia sp.*, bamboo; c) The Mixed deciduous forest, in this picture displaying *Tectona grandis*, *Lannea* sp. in family Anacardiaceae; d-e) The plain floras in the mixed deciduous forest displaying *Smilax* sp. in family Smilacaceae (Source: Wattanapituksakul 2006)

2) Recent Faunal resources

No survey on the fauna in the northern Thailand had been undertaken and as a result, nothing is available to establish the checklists of the diversity of mammals. However, the faunal assemblages categorized by Lao Yi Pa and Tacumma (2000) in the Indochina sub-region, are significant. The diversity of mammals in Pang Mapha district is similar to that in Myanmar or in Indochina (Parr J.W. 2003; Amphansri 2004, 2005, 2011; Wattanapituksakul 2006). The survey of modern village inhabitants in Lang River basin worked out a total of 67 mammal species that have been observed in the study area (Lao Yi Pa and Tacumma 2000; Srikosamart et al. 1999; Wangwacharakul et al. 2000). Those mammals are particularly known in the region and have been eaten in the historical period as following:

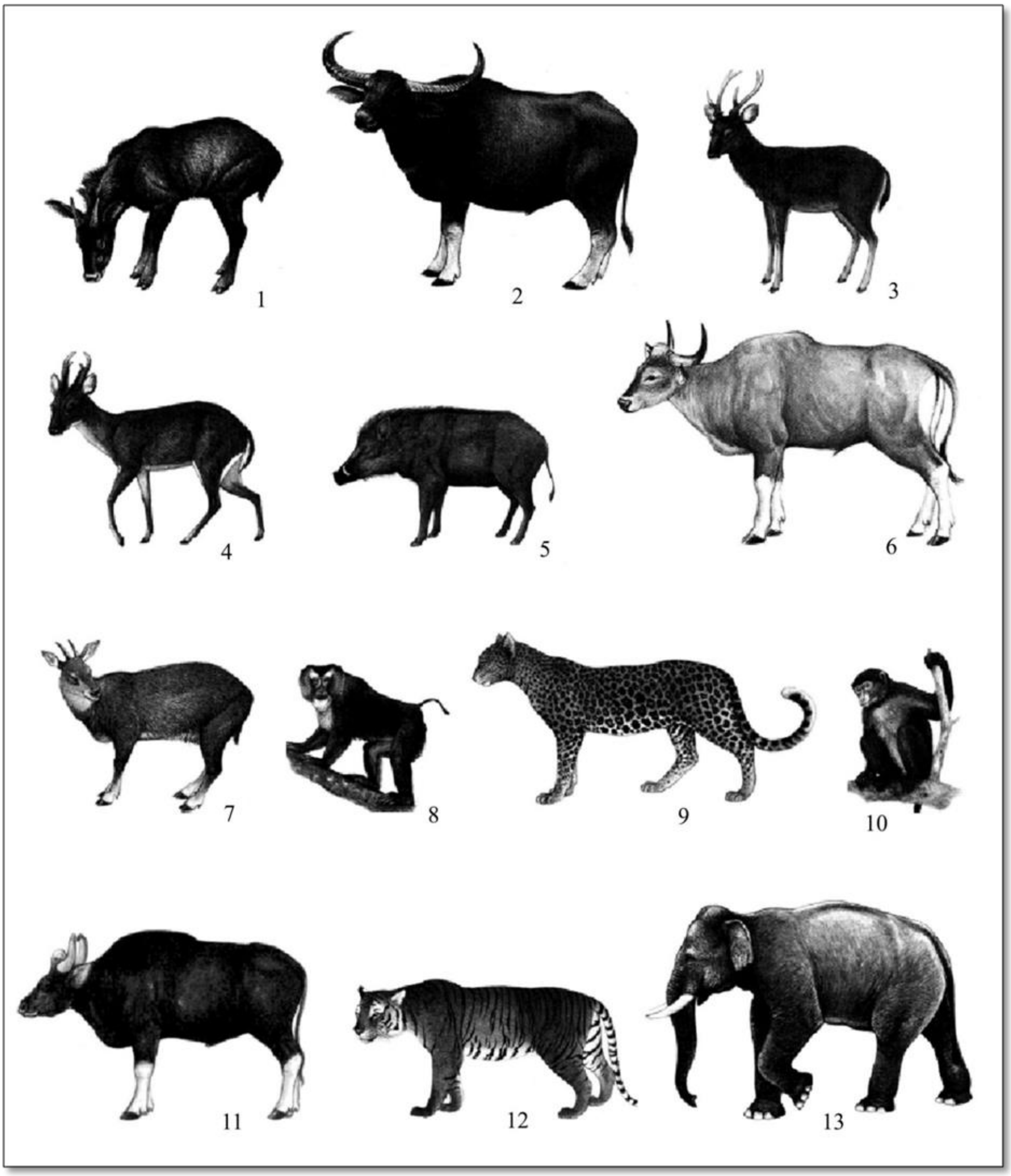
Mammals size	**Type of mammals (Species)**
Larger bodied mammals **(figure 2.2.5)**	- The larger bodied mammals are regularly discovered: *Elephas maximus* (Asia elephants), *Bos gaurus* (Gaur), *Bos javanicus* (Banteng), *Bubalus arnee (Wild water buffalo)*, *Panthera tigris* (Tiger), *Panthera pardus* (Leopard or panther), *Muntiacus muntjak* (Common barking deer), *Cervus unicolor* (Sambar dear), *Naemorhedus sumatraensis* (Southern serow), *Naemorhedus caudatus* (Long-tailed goral), *Sus scrofa* (Eurasian wild pig), *Arctonyx collaris* (Hog badger), *Macaca* sp. (Macaque) and *Macaca mulatta* (Rhesus macaque).
	- Some large bodied mammals locally became extinct since the last 15 years, especially *Elephas maximus*, *Bos gaurus*, *Bos javanicus*, *Panthera tigris*, and *Panthera pardus* (Lao Yi Pa and Tacumma 2000).
Smaller bodied mammals **(figure 2.2.4)**	- The smaller bodied mammals are recorded in Pang Mapha district: *Presbytis* sp. (Langur), *Hylobates* sp. (Gibbon), *Hylobates lar* (White-handed gibbon), *Viverridae* (Civets), *Paradoxurus hermaphroditus* (Common palm civet), Felidae (Medium and small wild cats), Muridae (Rats and mice), Sciurinae (Squirrels), *Cynocephalus variegatus* (Sunda colugo), *Tupaia belangeri* (Northern tree shrew), and Chiroptera (Bats).
	- According to Wangwacharakul et al. 2000, the most abundant mammals, during historical times, influenced Pang Mapha district like *Macaca mulatta*, *Hylobates lar*, *Paradoxurus hermaphroditus*, *Sus scrofa*, *Muntiacus muntjak*, *Cervis unicolor*, and *Naemorhedus sumatraensis*.

Many of these species have been identified in the faunal archaeological records from Tham Lod and Ban Rai Rockshelters (Amphansri 2004, 2005, 2011; Wattanapituksakul 2006). The faunal remains were in poor condition of preservation and their analytical potential is low. The environment of North-western Thailand is principally composed of forests, hills, mountains and rivers, with a monsoonal season. It is likely that some parts of this region had been attractive for animals as a living place since prehistoric times. Nowadays, Thai archaeologists have emphasized the discovery of settlement patterns from rockshelters and village areas. But, some prehistoric sites in these areas were sporadically occupied by human groups, who exploited them in various aspects, what has quickly caused changes of environment (Shoocongdej 2001, 2002, 2003, 2004, 2005, 2007; Khaokhiew 2003, 2004; Amphansri 2004, 2005, 2011, Treekanchanawattana & Pumijumnong 2005; Wattanapituksakul 2006; Treekanchanawattana 2007; Krajaejun 2007). Therefore, the information about prehistoric sites was a little in question. They were indicated by some archaeological evidences, found from some parts of these areas.



Not to Scale

Figure 2.2.4 Some smaller bodied mammals found in northern Thailand 1) *Hylopetes alboniger* (Parti-coloured flying Squirrel), 2) *Tupaia belangeri* (Northern tree shrew), 3) *Presbytis* sp. (Langur), 4) *Paradoxurus hermaphroditus* (Common palm civet), 5) *Viverricula indica* (Small Indian civet), 6) *Rhizomys pruinosus* (Hoary bamboo rat), 7) *Hylobates lar* (White-handed gibbon), 8) *Felis chaus* (Jungle cats), 9) *Viverra zibetha* (Large Indian civet), 10) *Hystrix brachyuran* (East Asian porcupine) (Source: Parr John W.K 2003)



Not to Scale

Figure 2.2.5 Some larger bodied mammals found in northern Thailand, 1) *Naemorhedus sumatraensis* (Southern serow), 2) *Bubalus arnee (Wild water buffalo)*, 3) *Cervus unicolor* (Sambar dear), 4) *Muntiacus muntjak* (Common barking deer), 5) *Sus scrofa* (Eurasian wild pig), 6) *Bos javanicus* (Banteng), 7) *Naemorhedus caudatus* (Long-tailed goral), 8) *Macaca* sp. (Pig-tailes macaque), 9) *Panthera pardus* (Leopard or panther), 10) *Macaca mulatta* (Rhesus macaque), 11) *Bos gaurus* (Gaur), 12) *Panthera tigris* (Tiger), 13) *Elephas maximus* (Asia elephants) (Source: Parr John W.K 2003)

2.3 Overviews of the Highland Pang Mapha

The highland Pang Mapha is well known for its beautiful and dramatic landscape; it is situated at latitude 19° 31′ north and longitude 98° 14′ east, located in Mae Hong Son province, covering an area of approximately 1210 sq km. Pang Mapha district is located about 150 km northwest of Chiang Mai **(figure 2.3.1)**. The landscape and topography are influenced by the limestone mountain ranges, suitably extended in the north-south direction. The altitude ranges from 400 meters to over 1200 meters above sea level. The neighboring areas are (from southeast clockwise) Pai district, Mueang Mae Hong Son district and Shan state of Myanmar. According to Kiernan et al. 1988, the topography of this area exposes approximately 90% of high mountains (high limestone) and 10% of valleys, comprised of high and low alluvium.

This region contains many caves and rockshelters. It includes five river drainages: Mae Lana, Pong Sean Pik, Khlong, Lang, and Rang Luang (Khaokhiew 2003, 2004; Shoocongdej 2006). The district Pang Mapha is divided into 4 subdistricts (Tambon) comprising 38 villages namely Tambon Soppong, Tambon Pang Mapha, Tambon Tham Lod and Tambon Napu Pom. The people of this region belong to various ethnic groups: the Shan, Karen, Red and Black Lahu, Chinese, Lawa and Thai **(figure 2.3.2)**. In addition, this area has a tropical monsoon climate, with well-pronounced wet and dry seasons (Shoocongdej 2000, 2003, 2004, 2006; Wattanapituksakul 2006). The temperatures are quite similar to other districts in Mae Hong Son. The average annual rainfall is approximately 1300 mm a year, and various types of forests could be found in Pang Mapha.

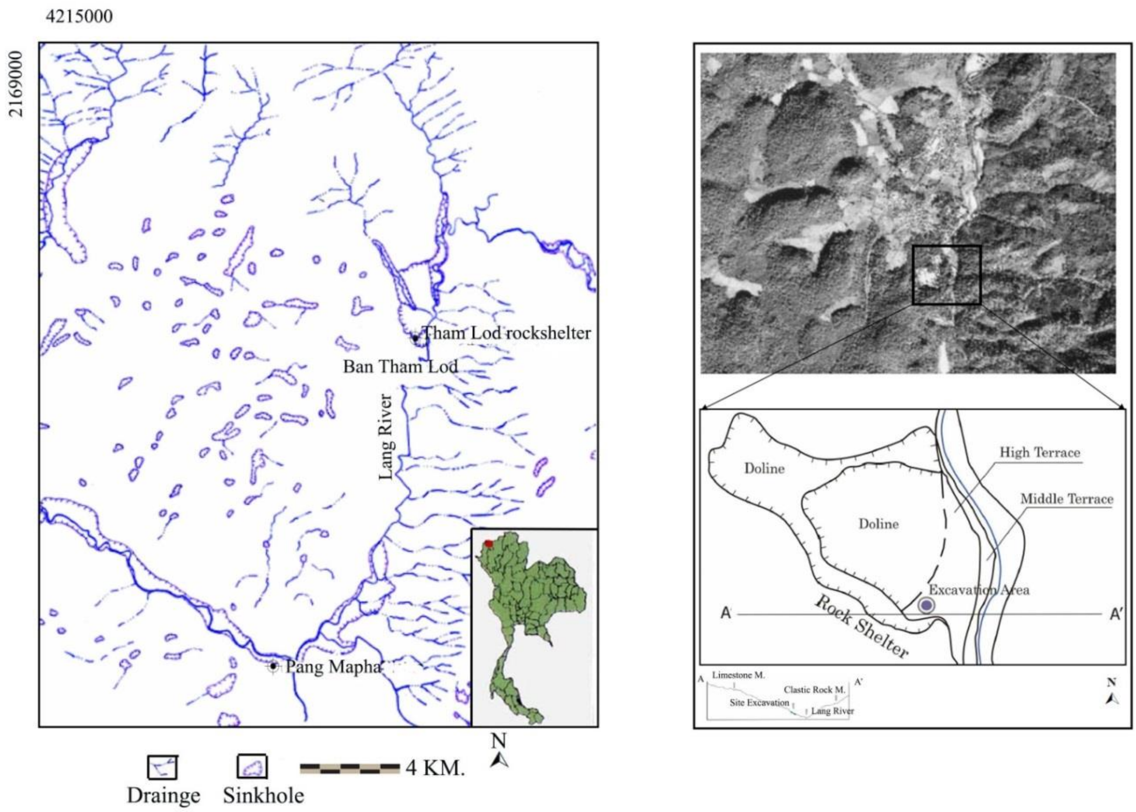
Figure 2.3.1 Map of north-western Thailand, showing the location of Pang Mapha district (Source: http://www.sjonhauser.nl/pang-mapha.html)

Figure 2.3.2 The ethnographic and socio-cultural environment at Pang Mapha district, Mae Hong Son Province, North-western Thailand (Source: https://www.google.fr/search?q=Pang+Ma+Pha+life & people?)

2.3.1 Geology and geomorphology

Proper investigation of aerial photos can help a lot towards understanding the geology and geomorphology of the region by highlighting the outline of Highland Pang Mapha. According to Khaokhiew (2004), the origin of geomorphic landform is based on the geographical features, which include some surface drainage patterns. The fault line in the north-south direction was interpreted as the boundary of clastic and non - clastic rock mountains (Richardson 2003; Khaokhiew 2003, 2004; Marwick 2008).

The Permain limestone is detectable in the western part of the Nam Lang River. The limestone is highly weathered and eroded into fantastic forms, making the karst topography, with caves, rockshelters and dolines. These morphological features (caves and rockshelters) offer opportunities of settlement and of performing some activities for the prehistoric people (Khaokhiew 2003, 2004). Tham Lod Rockshelter is situated at the rim of a collapsed and open doline, not a closed depression but easy to access and of nearly circular shape around 100 m of diameter. The elevation is approximately 600 to 640 m above sea level. Sediments accumulated in the doline are comprised of non-soluble rocks, combined with buried karst infilling and thick high terrace deposits **(figures 2.3.3 & 2.3.4)**.



Source: Interpretation from aerial photos (PCD. project: 17/12/1995)

Figure 2.3.3 Geomorphological map, showing the location of Tham Lod Rockshelter (Source: Khaokhiew 2004)

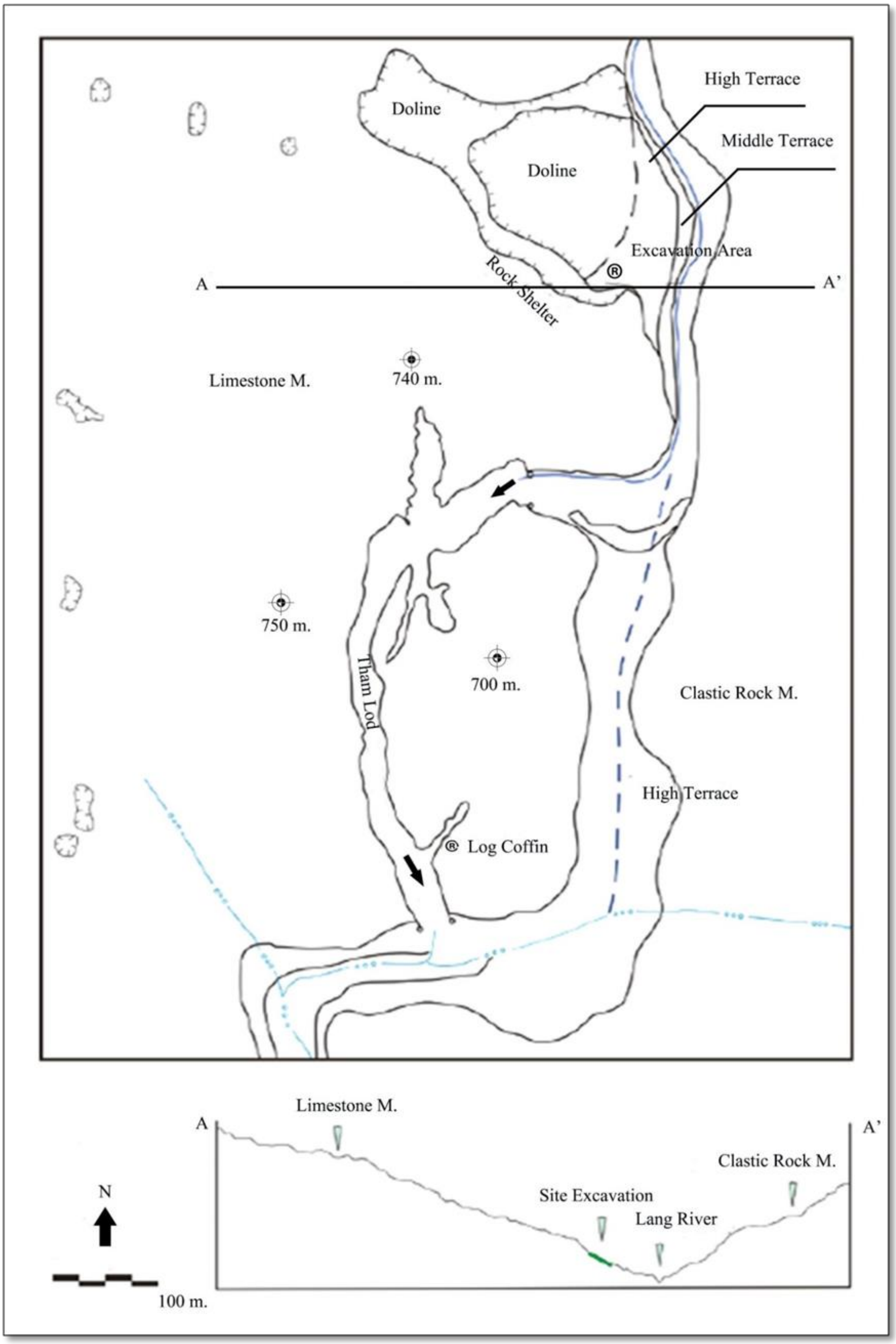


Figure 2.3.4 Map and topographic profile of Tham Lod cave, doline and rockshelter, showing geomorphological features along the Lang River (Source: Khaokhiew 2004)

In the eastern side of Nam Lang River, the clastic rocks are mostly composed of sandstone, mudstone, shale and chert, referred to Permo-Carboniferous age **(figures 2.3.5 & 2.3.6)**. Besides the north-south orientation, the geomorphology is characterized by the highly mountainous ranges with elevation between 600 m and 1070 m above sea level. These mountains are called "Doi San Kai" by local people (Khaokhiew 2003, 2004). From the geological investigation on this unit, numerous stone assemblages were found on the top of the mountain.

In the western side of Nam Lang River, the Quaternary sediments have accumulated in the form of terraces and flood plain deposits. They appear in some small areas, parallel to Nam Lang River. Most of them are semi-consolidated and unconsolidated: sand, silt, clay, gravel etc. (Shoocongdej 2001, 2002, 2003; Richardson 2003; Khaokhiew 2003, 2004; Marwick 2008).

Figure 2.3.5 Geologic map of study area, showing the location of the Tham Lod Rockshelter, Pang Mapha district (Source: Khaokhiew 2004)

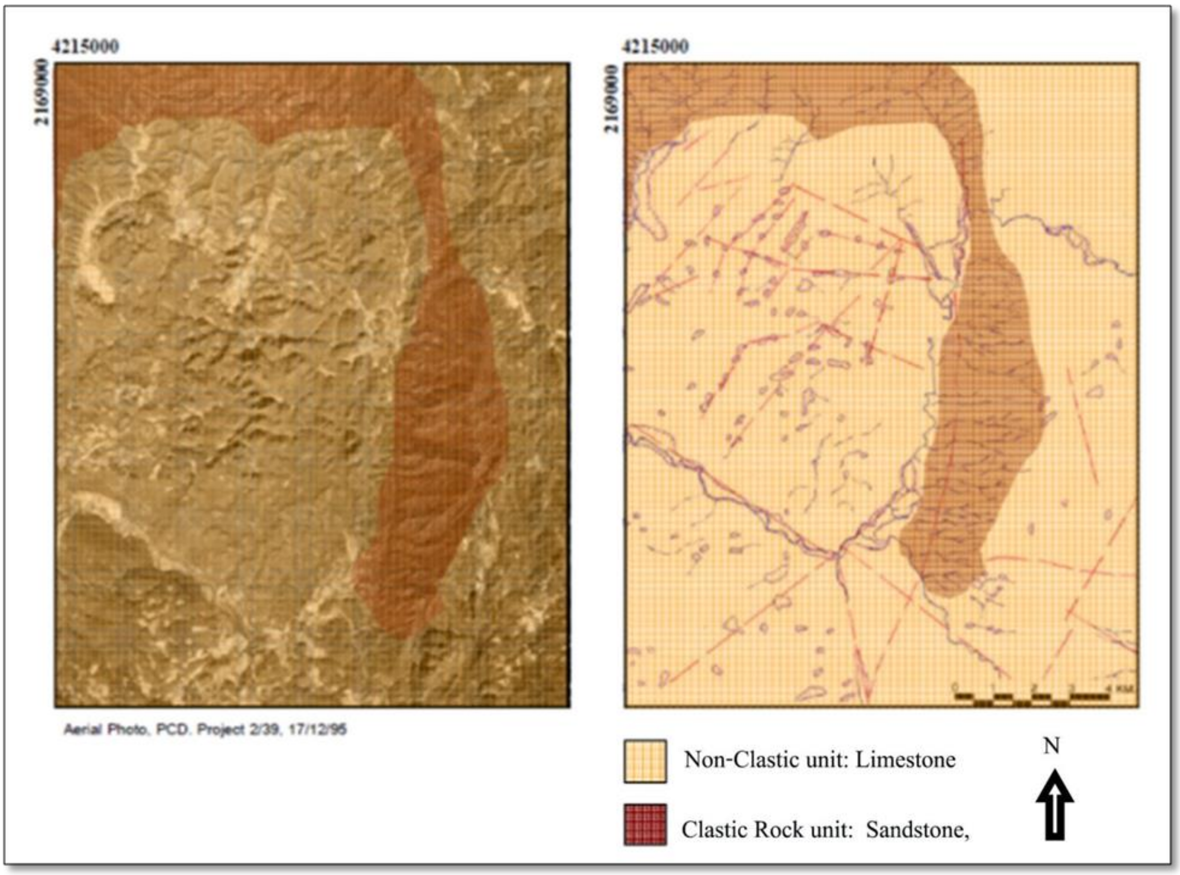


Figure 2.3.6 Interpretation map from aerial photo, showing the rock units in Pang Mapha district (Source: Khaokhiew 2004)

2.3.2 Geographical features and environmental setting

The geographical and environmental setting is important to understand the habitat settlements. All information will highlight the aspects of physical landscape and natural environment in the Highland Pang Mapha. This is of significant importance towards the activities of prehistoric people who were settled in this region. The high diversity of habitats and the abundance of accessible natural resources, existing in the area, could be demonstrated. The open site area, river and transitional zone area are considered within a broader context of Tham Lod Rockshelter such as caves and rockshelters (**figures 2.3.7 and 2.3.9**). Therefore, the Highland Archaeology Project radically focused on this information (Wangwacharakul et al. 2000; Shoocongdej 2001, 2002, 2003, 2004, 2005, 2007; Khaokhiew 2003, 2004).

Generally, Tham Lod cave and rockshelter were suitable locations for the permanent places of prehistoric people because the landmarks helped them to settle along period, even climatic changes: wet and dry seasons. This region was stable for settlement. Hence, the Pang Mapha district, mainly in the vicinity of Tham Lod valley, was interesting for prehistoric people, as selected places for the habitat area. There was an appropriate place for settlement in open areas, befitting for hunting and gathering. Besides, in this area, some types of landforms were remarkably diversified: valley floors, hill, slope, ridges, high mountain and karst areas.

The Nam Lang River basin is a main river flowing near Tham Lod Rockshelter. The River exceedingly supports the wide varieties of plants and animals for the resident valley. Formerly, the prehistoric people used to take the deposit of gravels from river for knapping the tool implements. According to Richardson (2003), the Nam Lang River valley is a transitional zone area. It contains high rides separated by steep stream valley and their floodplains. The landscape is dominated by karst topography. The transitional zone exists between the karst and non-karst areas, and rather enables easily to access the surrounding diversity of habitats and natural resources, including the majority of climates, getting along with tropical monsoonal reason, compatible with wet and dry seasons (Richardson 2003; Khaokhiew 2003, 2004; Marwick 2008)

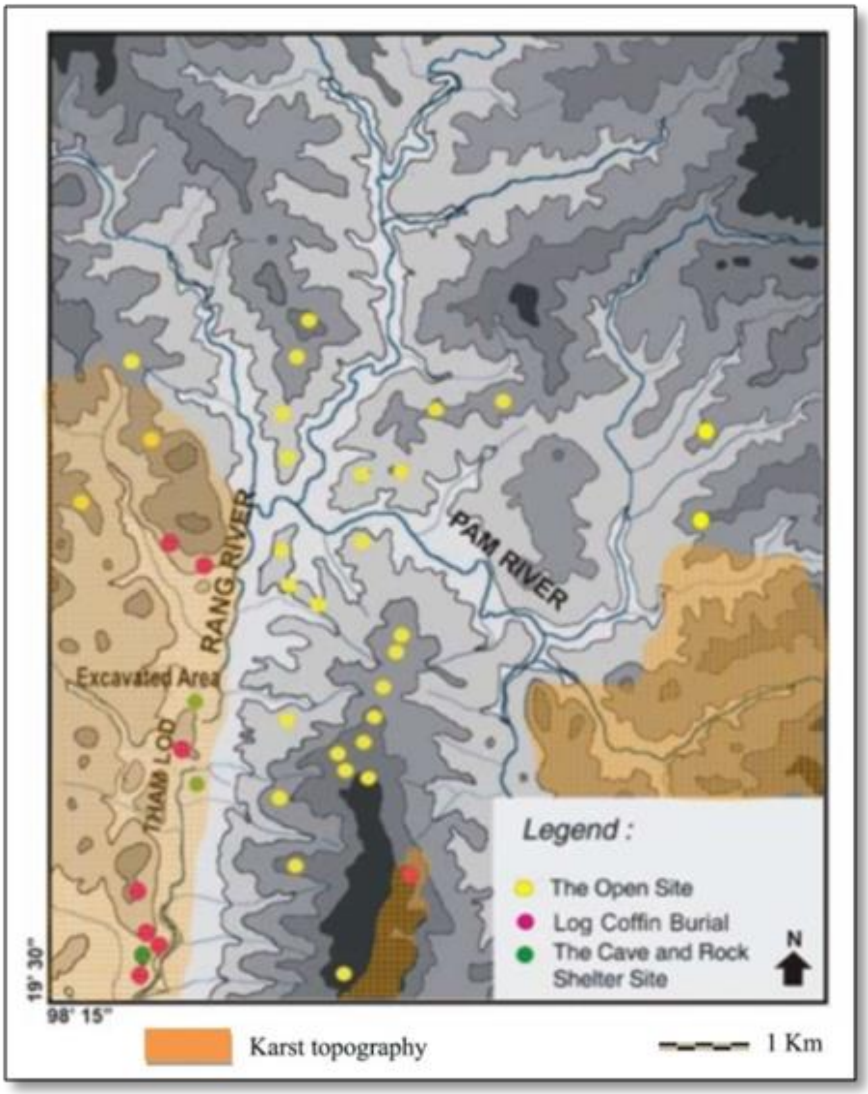


Figure 2.3.7 The location of prehistoric sites around Tham Lod Rockshelter (Sources: Khaokhiew 2004; Treerayapiwat 2005)

Figure 2.3.8 Geographic setting of Ban Tham Lod at Pang Mapha district, Mae Hong Son province (Source: Khaokhiew 2004)

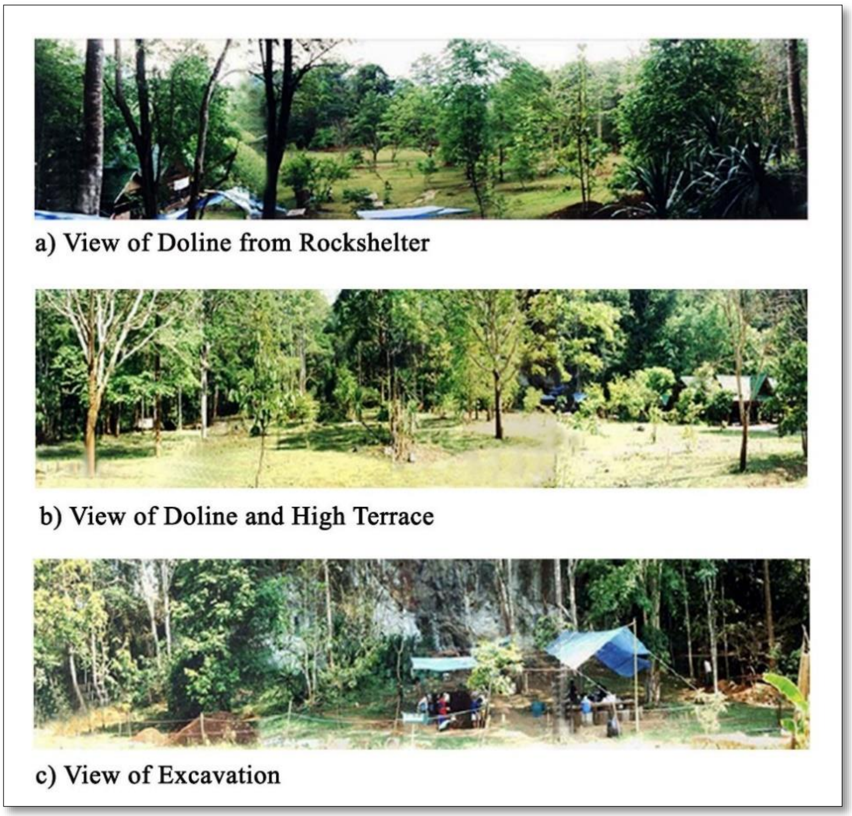


Figure 2.3.9 The geographic setting of Tham Lod Rockshelter, showing the different views of doline and excavation area (Sources: Khaokhiew 2004; Treerayapiwat 2005)

2.3.3 Research area: Ban Tham Lod Village

The main access to the area today is the highway from Chiang Mai to Mae Hong Son, via Soppong. Ban Tham Lod is a small village, approximately 10 km away from Soppong town. The administrative region is under orders of the Tham Lod Natural Education Station, which is controlled by Forest Department in the landmarks. The average topography ranges from 400 to 800 m above sea level. Ban Tham Lod is well known for its beautiful landscape **(figure 2.3.10a, b, d)**; many tourists come and visit the caves and the natural landscape during cold period (November to February). The "Pi Maen" caves, with remains of archaeological teakwood coffins dating from around 1400 years ago **(figure 2.3.10c)**, are places of interest for most tourists. These caves are the home of birds, particularly of thousands of swifts coming in at evening, and also thousands of bats going out at the same time. This place is one of the 80 caves in district Pang Mapha.

The main local river is the Nam Lang River that follows a north to south orientation. In the southwest area, it completely flows into a sinkhole, and follows the west of the Ban Rai Rockshelter site. From this active longest stream, it sooner joins the Mae Nam Khong River, which flows southwards to meet the Mae Nam Pai (Shoocongdej 2001, 2003, 2004, 2006, 2007; Richardson 2003; Khaokhiew 2003, 2004). Later on, this river flows westward, towards the city of Mae Hong Son.

a) Ban Tham Lod b) Bamboo forest

c)Tham Lod Cave d) Nam Lang River

Figure 2.3.10 Environmental setting around Ban Tham Lod village, Pang Mapha district; a) BanTham Lod, b) Bamboo forest, c) Tham Lod Cave, and d) Nam Lang River (Source: https://www.google.fr/search?q=Pang+Ma+Pha+enviroments & source?)

2.3.4 Location of Tham Lod Rockshelter

Tham Lod Rockshelter site is one of the abundant archaeological caves and rockshelters in the limestone karst region of north-western Thailand. The site is located near Tham Lod Village, Pang Mapha district, Mae Hong Son province. There is a mound situated at proximally 19º 34´ north and 98º 16´ east (Military map 1976). It is located 640 meters above sea level, and 3 meters above the base of the cliff (Shoocongdej 2001, 2003, 2004, 2005, 2006; Khaokhiew 2003, 2004). Tham Lod Rockshelter is related to Tham Lod Natural Education Station (Thai Foresters of the Royal Forest Department) **(figure 2.3.11)**.

The site is approximately at 250 meters away from a Nam Lang River, which is a part of the large Salawin River drainage basin, and at over 20 m above the highest water level (Khaokhiew 2003, 2004; Shoocongdej 2006). In a geographical perspective, the Tham Lod Rockshelter is a small north-facing rockshelter, located at the base of an over-hanging Permain limestone cliff (Shoocongdej 2006). There is approximately 20 m high, and the floor of the rockshelter has generally a flat area, around 10 m wide and completely extends on about 5 m. From the base of the cliff to the drip-line, it is interspersed with large boulders (Khaokhiew 2003, 2004; Shoocongdej 2006). Nowadays, the site is well preserved and easy to access in the surroundings of the Tham Lod Natural and Wildlife Education Center. The vicinity of the rockshelter was developed into a forest management and education station, including several small buildings and a playing field **(figures 2.3.11 & 2.3.12)**. According to Marwick (2008), this recent development has rather obscured the natural topography and vegetation; probably, it is making shelters more exposed than in the past.

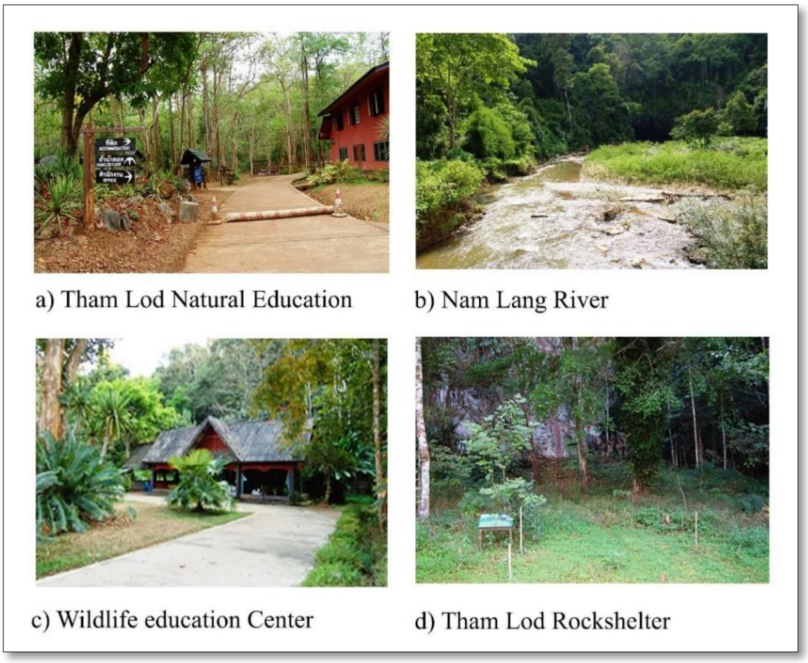


Figure 2.3.11 Surroundings of Tham Lod Rockshelter: a) Tham Lod Natural Education, b) Nam Lang River, c) Wildlife education Center, and d) Tham Lod Rockshelter (Photographs by Chitkament 2010)

Figure 2.3.12 Location of Tham Lod Rockshelter, near Tham Lod Natural and Wildlife Education Center of Forest Department (Sources: Shoocongdej 2003; Khaokhiew 2004)

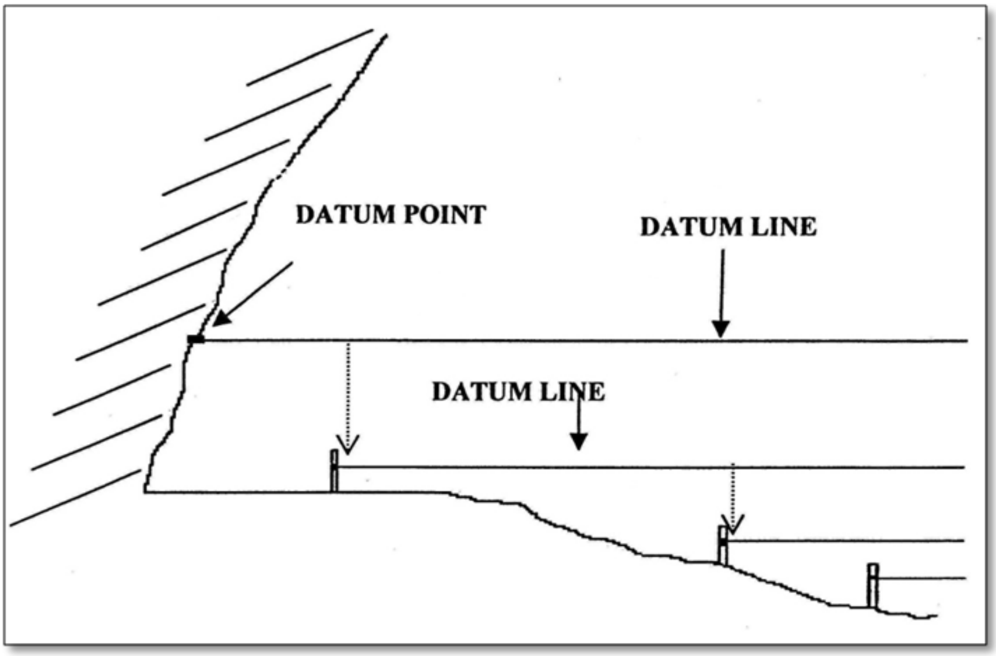


Figure 2.3.13 Map of excavation layout at Tham Lod Rockshelter, showing the reference system, using a datum point and datum lines (Source: Shoocongdej 2003)

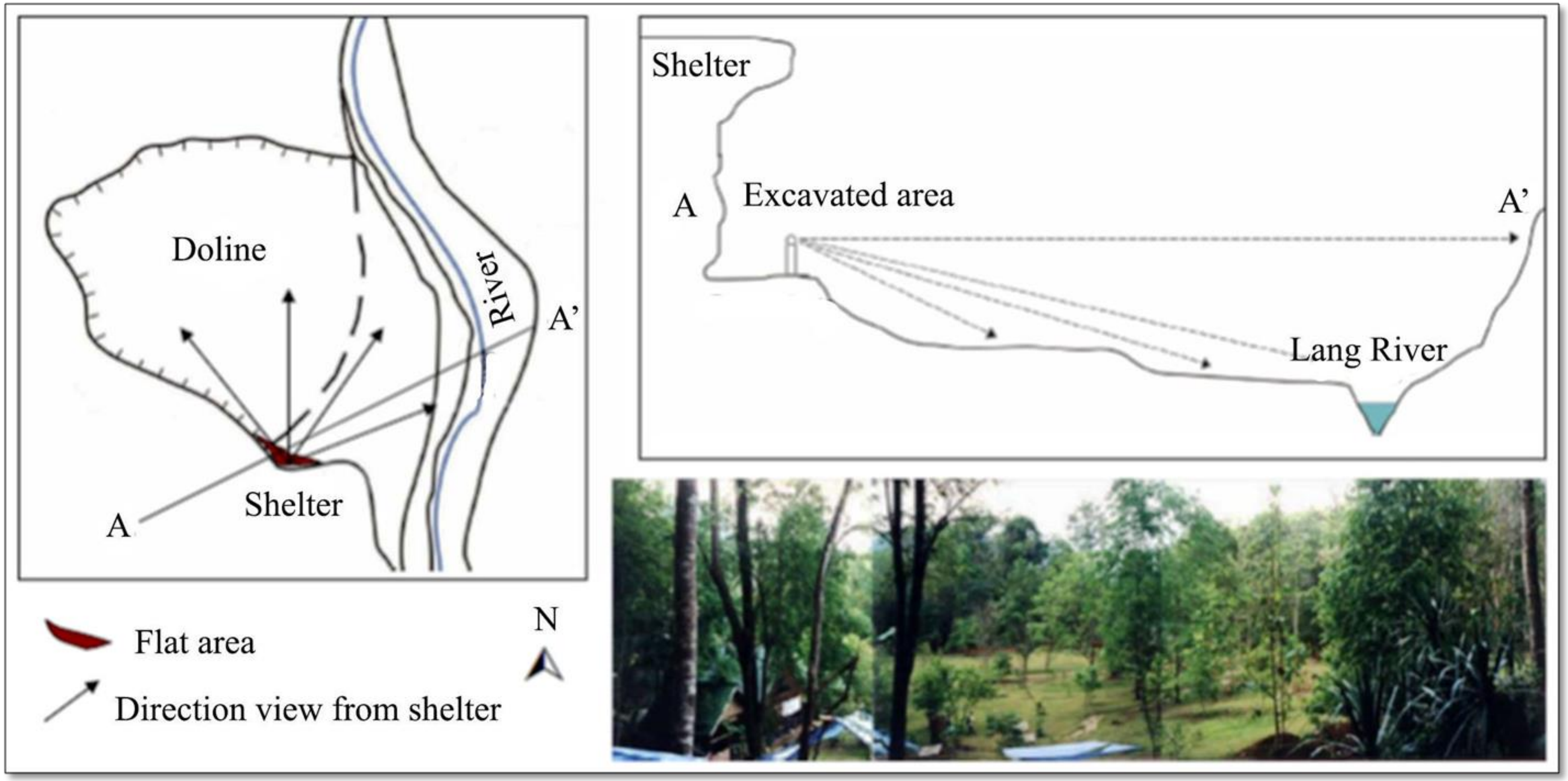


Figure 2.3.14 Direction view from the Tham Lod Rockshelter, related to the natural resources (Source: Khaokhiew 2004)

2.3.5 History of excavations at Tham Lod Rockshelter

The site of Tham Lod Rockshelter was discovered by John Spies, a local Australian resident settled with his family, who has investigated the caves and rockshelters in Northwestern Thailand. In 2001, the Tham Lod Rockshelter has been recorded by the Highland Archaeology Project in Pang Mapha (HAPP). During this first field season, the project mostly focused on surface collections. After that, R. Shoocongdej (2006) returned to the site to conduct excavations between April and June 2002. The sampling plane of excavation covered three areas with a total excavated area of 34 sq m **(figure 2.3.13 & 2.3.15)**.

The site of Tham Lod Rockshelter was excavated from 2002 to 2006 in the context of the Highland Archaeology Project conducted by R. Shoocongdej and supported by Thailand Research Funds (TRF) and Silpakorn University (Shoocongdej 2000, 2001, 2002, 2003, 2004, 2005, 2007). Tham Lod site is a well-developed stratified archeological sequence. It is the most know of the prehistoric sites in North-western Thailand, mainly for the burial places. This site is among the most important in the region, as it allows researches about prehistoric hunter-gatherers.

More than hundred thousand archaeological remains were unearthed from the layers belonging to the time period between late Pleistocene and Holocene: stone artefacts, faunal remains including number of freshwater shellfishes, and floral remains, as well as potshards and some metal items in the Holocene upper layer (Shoocongdej 2001, 2002, 2003, 2004, 2005, 2006, 2007; Khaokhiew 2003, 2004; Khaewkamput 2003; Amphansri 2004, 2005, 2011; Pureepatpong 2004, 2006; Kheawtaya 2005; Treekanchanawattana and Pumichumnong 2005; Wattanapituksakul 2006; Krajaejun 2007). Moreover, the site seems to have the potential to produce significant data for reconstructing paleoenvironment, determining seasonality of site use, and constructing an absolute chronological sequence. Many datations have been processed on different materials with different methods, and have provided remarkable dates ranging from ca. 35,000 B.P to about 3000 B.P (without Middle Holocene period). The site has generally well preserved the faunal and flora remains (Pumijumnong 2003; Amphansri 2004, 2005, 2011; Treekanchanawattana and Pumichumnong 2005; Wattanapituksakul 2006; Pumijumnong et al. 2006; Krajaejun 2007). It has yielded a considerably rich industry, comprising numerous lithic artefacts and a few bone tools. The multidisciplinary studies, conducted as far, indicate that this site was utilized as a temporary settlement, where activities such as food preparation and lithic production were practiced (Shoocongdej 2003, 2004, 2005, 2006).

Two burials and two more fragmentary skeletons were notably exposed in the area 1, near the wall of the rockshelter **(figure 2.3.15)** in the final Pleistocene layers. Several remains of fauna, shells, flakes and used pebble tools were associated with the burials (Khaewkamput 2003; Khaokhiew 2003, 2004; Amphansri 2004, 2005, 2011; Pureepatpong 2004, 2006; Kheawtaya 2005; Treekanchanawattana and Pumijumnong 2005; Wattanapituksakul 2006; Krajaejun 2007; Marwick 2008).

2.3.6 Excavations Method

Three trenches have been defined for the excavation at Tham Lod Rockshelter **(figure 2.3.15).** A horizontal grid system was employed by establishing north-south base-lines for trenching detail (Khaokhiew 2003, 2004; Shoocongdej 2003, 2004, 2005, 2006). Sections were drawn and some strata were correlated between the different excavation areas, due to across-the-board slope of deposits.

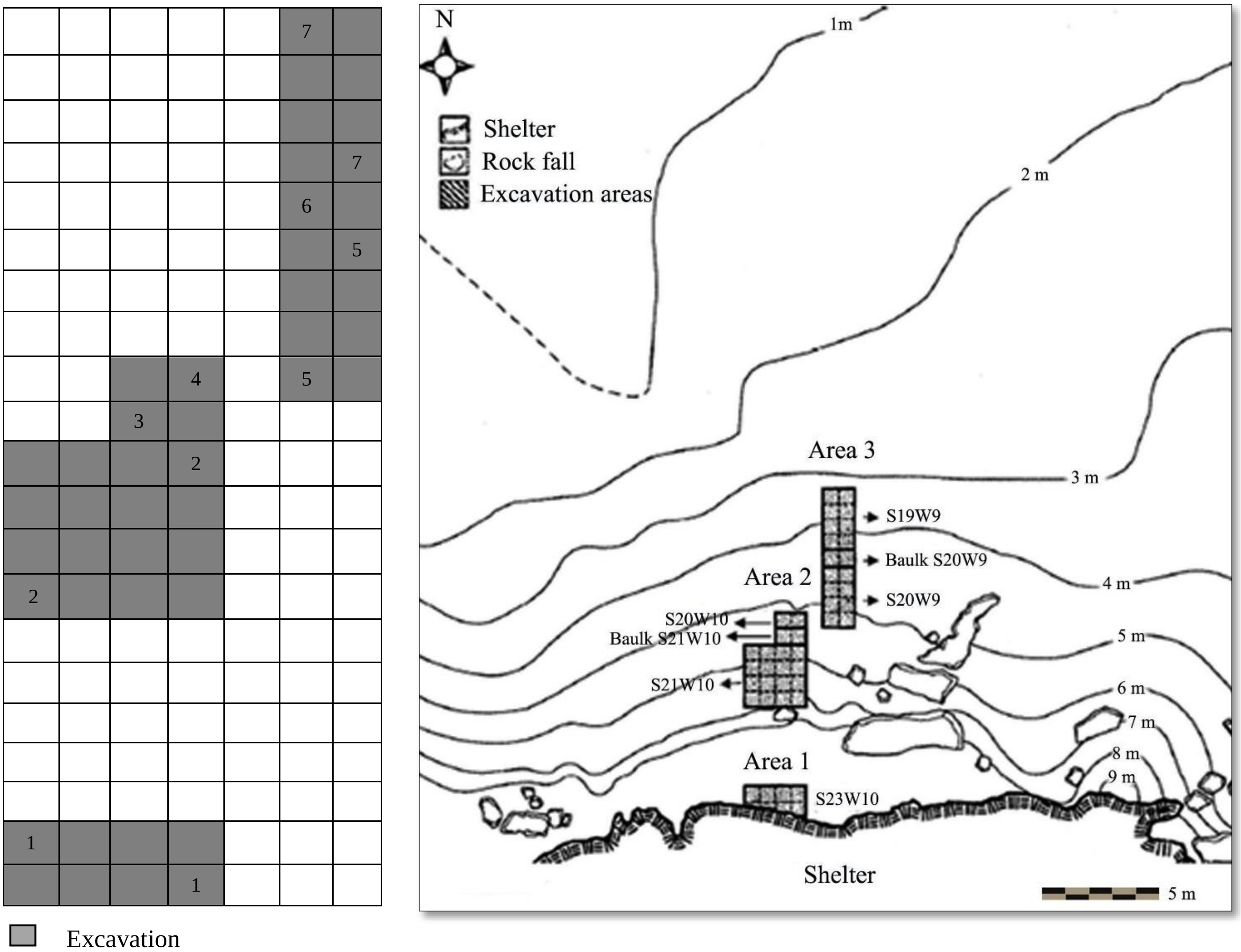


Figure 2.3.15 Plan of excavation at Tham Lod Rockshelter, showing the location of excavation areas; 1= Sector S23W10, 2 = Sector 21W10, 3= Sector Baulk S21W10, 4= Sector S20W10, 5= Sector S20W9, 6= Sector Baulk S20W9, 7= sector S19W9 (Sources: Shoocongdej 2003; Khaokhiew 2003, 2004)

1) Tham Lod Rockshelter Area 1

The area 1 is against the wall of the shelter, located on the talus **(figure 2.3.16)**. It is 4 meters long and between 1.5 meters and 2 meters wide, depending on the shape of the back wall (Khaokhiew 2003, 2004; Shoocongdej 2003, 2004, 2005, 2006). This area is quite flat on the floor (open area), beneath the overhang which is protecting it. This is the first area which has been excavated and it corresponds to the sector S23W10, which might be considered a habitation and also a burial place.

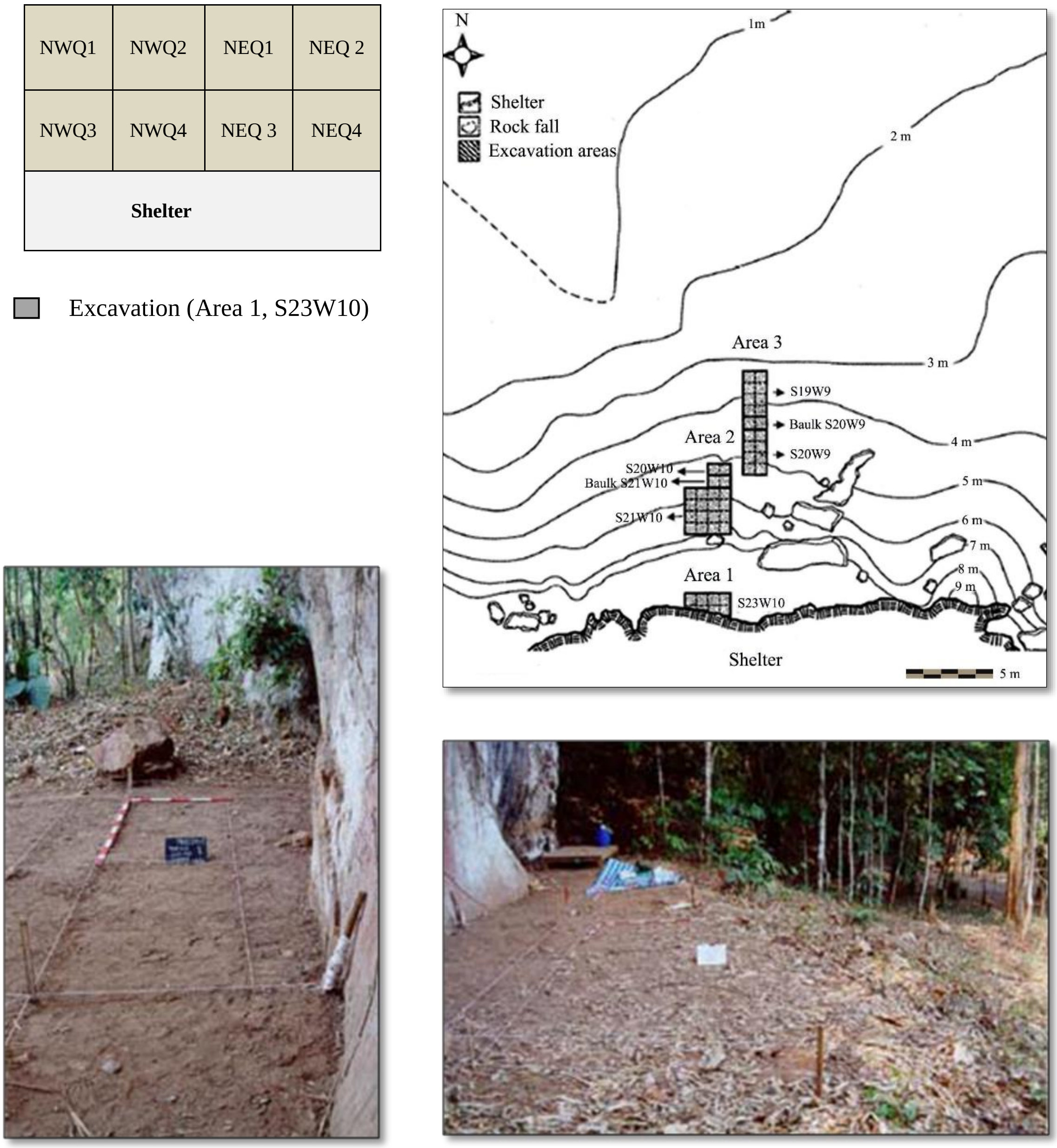


Figure 2.3.16 Plane of excavation of area 1 and photos before excavation (Sources: Shoocongdej 2003; Khaokhiew 2003, 2004)

2) Tham Lod Rockshelter Area 2

The area 2 is a hillock formed on the slope of the talus deposit, in front of the cliff overhang, about 6 to 7 m from the wall to the north. It is inclined between 25° and 30°. This area was occasionally interspersed by large boulders of limestone rock fall, which was covered by sediments (Khaokhiew 2003, 2004; Shoocongdej 2003, 2004, 2005, 2006). The excavation of area 2 was measuring 2 x 6 m, and divided into three sectors from south to north: sectors S21W10, Baulk S21W10 and S20W10 **(figure 2.3.17)**.

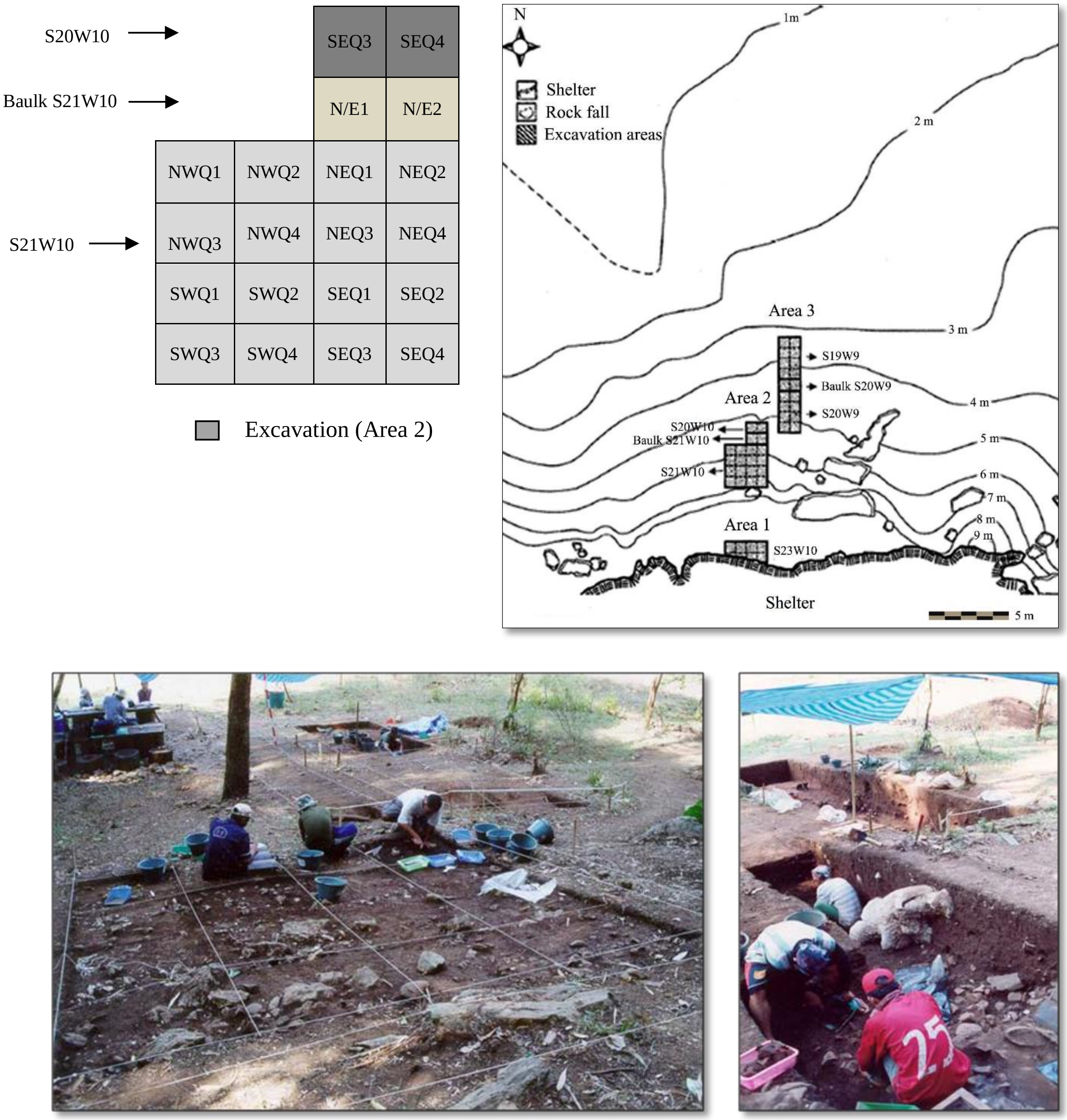


Figure 2.3.17 Plane of excavation of area 2 and photos of the excavation in progress (Sources: Shoocongdej 2003; Khaokhiew 2003, 2004)

3) Tham Lod Rockshelter Area 3

The area 3 is a foot slope and the sediments combine portions of the terraces and deposits from area 2. It is located about 15 meters ahead to the north of the shelter's wall (Khaokhiew 2003, 2004; Shoocongdej 2003, 2004, 2005, 2006). The excavation was settled on an area of 9 x 2 m, noteworthy interspersed with some limestone blocks (rock fall). This area has been divided into three sectors of excavation: sectors S19W9, Baulk S20W9 and S20W9 **(figure 2.3.18)**.

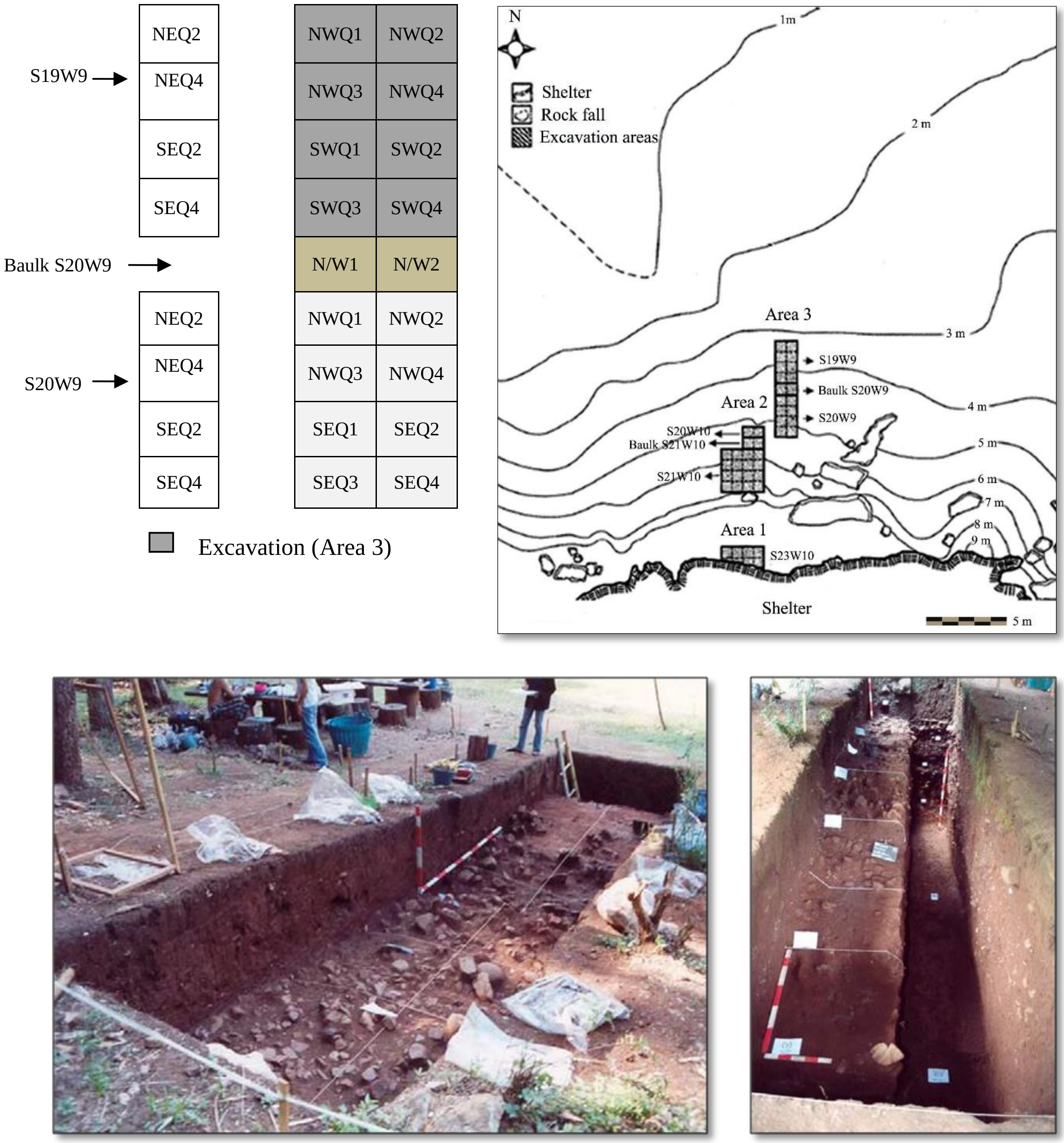


Figure 2.3.18 Plane of excavation of area 3 and photos of excavation (Sources: Shoocongdej 2003; Khaokhiew 2003, 2004)

2.4 The stratigraphic sequences of Tham Lod Rockshelter

Significant archaeological material was found throughout the stratigraphic sequence. The assemblages were mainly comprised of various stone artefacts, human skeletons, faunal, floral remains and freshwater shellfishes. This material supplies information about the past human behavior. The assemblage categories were separately analyzed in order to evaluate the changes along the stratigraphy. Following the understanding of the stratigraphy by the geologists **(figures 2.4.2 and 2.4.3)**, the archaeological remains have been grouped and studied by layer in order to establish a preliminary interpretation that can be compared with the other prehistoric sites in Thailand and Southeast Asia.

The stratigraphic layers of the Tham Lod Rockshelter have been labeled by Khaokhiew (2002). To classify the archaeological stratification, he took into account the quantity and the type of assemblage. From the excavation report, the details about the natural stratigraphic layers, soil sediments and archaeological remains are provided in the following pages.

Figure 2.4.1 Photos of excavation, showing the location of areas 1, 2 and 3 at Tham Lod Rockshelter (Source: Khaokhiew 2004)

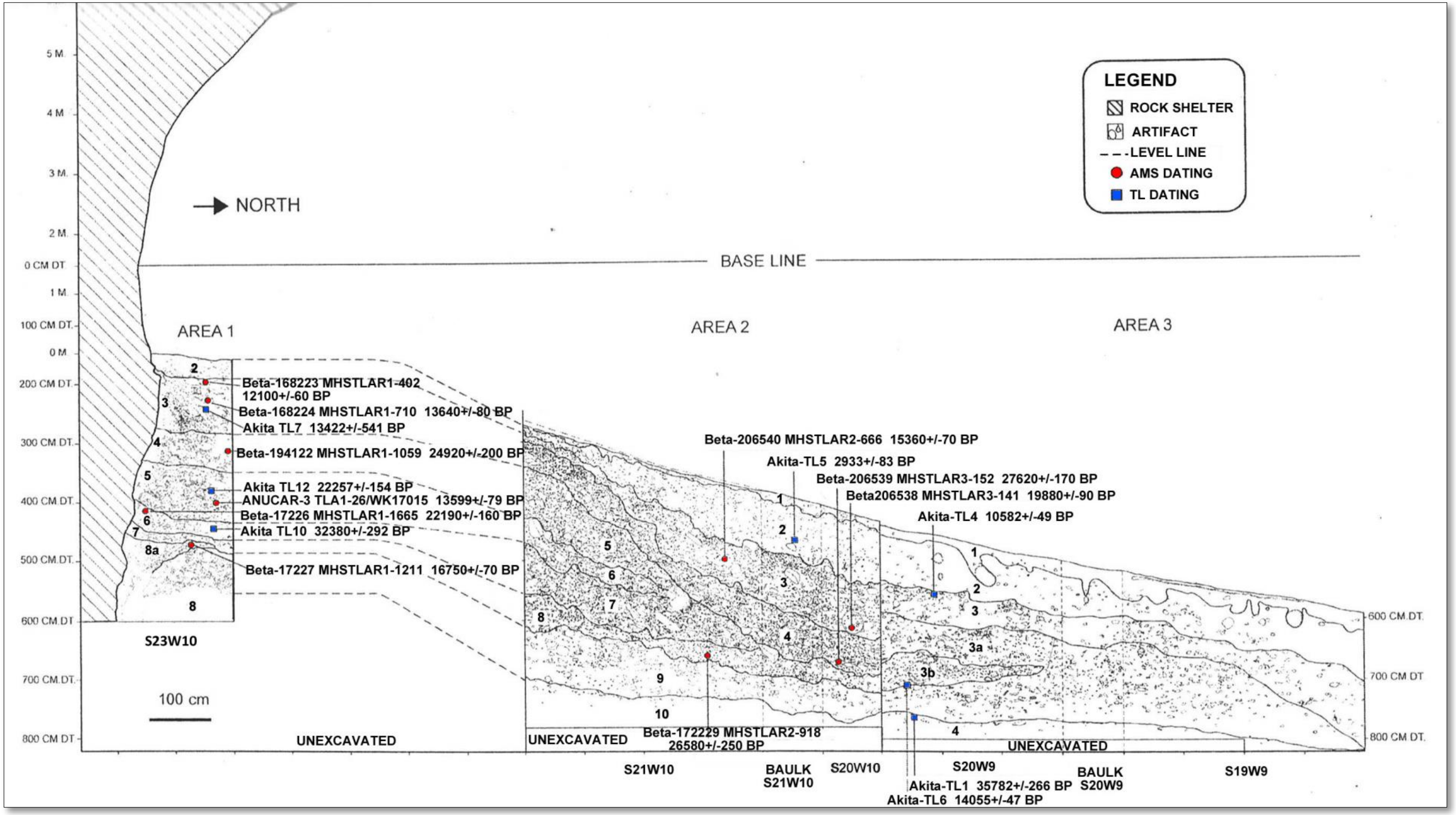


Figure 2.4.2 Combined stratigraphic sequence of areas 1, 2 and 3 at Tham Lod Rockshelter (Sources: Wattanapituksakul 2006; Shoocongdej 2007)

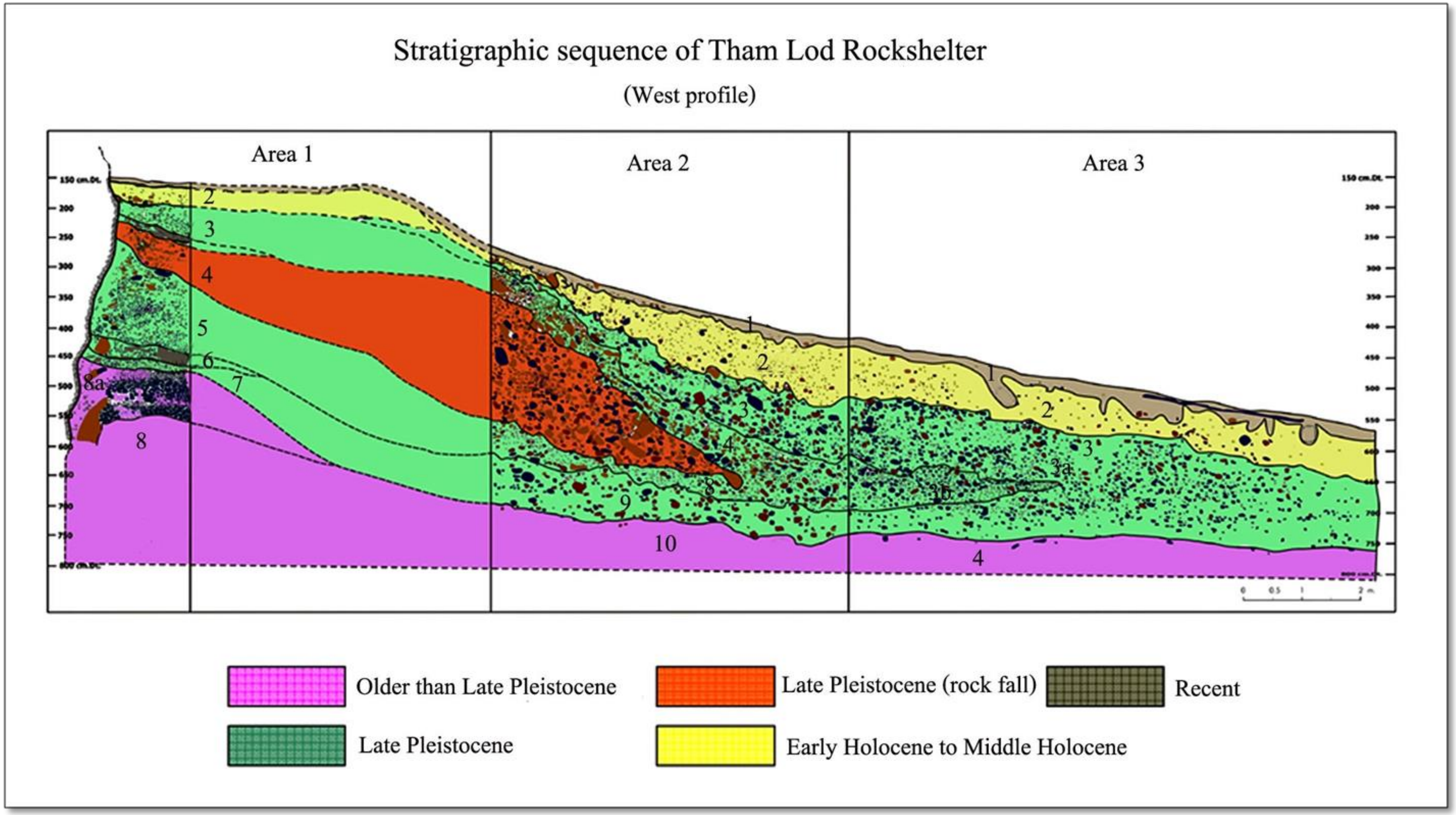


Figure 2.4.3 Combined stratigraphic sequence of areas 1, 2 and 3 at Tham Lod Rockshelter (Sources: Khaokhiew 2003, 2004; Wattanapituksakul 2006)

2.4.1 Stratigraphic sequence of area 1

The area 1 of Tham Lod Rockshelter is an open area on a flat floor, adjacent to the shelter wall. The sequence is interspersed by large boulders, and fully covered by the powdery silt also covering the talus (Khaokhiew 2003, 2004). The stratigraphic sequence of area 1 is comprised of 45 levels grouped into 8 layers **(figures 2.4.4 and 2.4.9)**. The Pleistocene deposits are made up of layers 3 to 8 with a thickness reaching approximately 3.5 m. The stratigraphic sequence in the north profile (S23W10) is one example, which is focused on the details of the features, and is descriptive for all layers in the site, from the upper to the lower layers **(Tables 2.4.1 to 2.4.7)**. Among them, the layers 1 and 2 correspond to the upper levels and belong to the Holocene. Layer 3 is considered the middle layer with the layer 4 that seems to be accumulated as a rock fall. Then the layers 5 through 8 make up the lower levels.

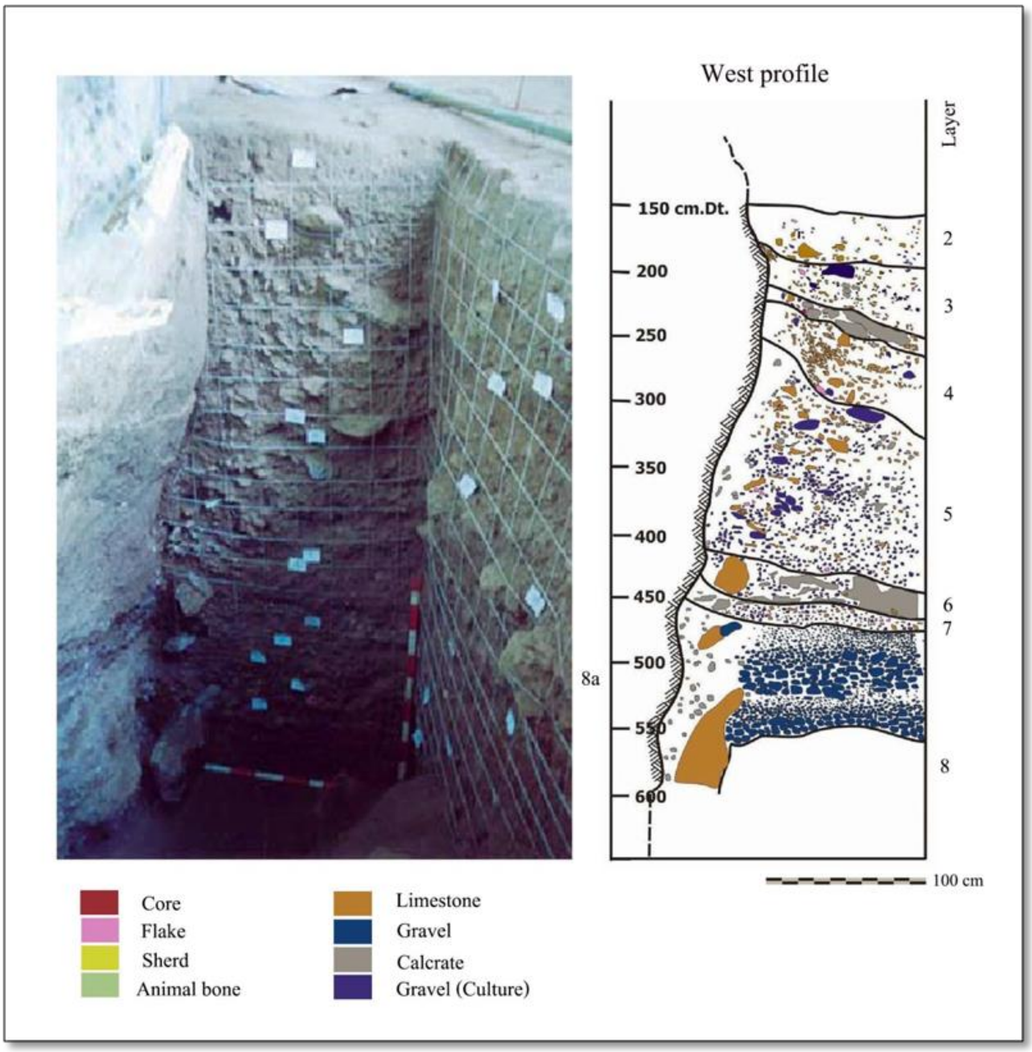


Figure 2.4.4 Stratigraphic sequence and vertical distribution of archaeological material in area 1, sector S23W10 of Tham Lod Rockshelter (Source: Khaokhiew 2004)

The natural stratigraphy of area 1 sector S23W10

Stratigraphic layers and depth in cm below datum	**Levels and features (depth in cm from surface)**	**Soil characterisation**	**Type of feature**	**Archaeological materials**	**Soil samples analysis**
layer 1		North profile			West profile
150-163,153-167	Surface (3-4)	- 10YR 4/3 brown, loamy soil (sand, clay, loam), moderately fine-textured, organic matter 2.7, moderately alkaline (pH 8).	- Small limestone fragments are combined with loamy soil, besides ashes and charcoals.	- Some archeological remains: animal bones and teeth, core tools, flake fragments, flakes, shells, potsherds and floral remains, along with other recent items like metal, cans, buttons, glasses, coins and iron fragments.	- 10YR 3/3 dark brown, organic matter 2.71, 62.57% sand, 15.76% silt and 21.67% clay. - Loamy soil (sandy, silty, loamy), moderately fine-textured, moderately alkaline (pH 8).
164-196	Feature 3 (14-46)	10YR 4/4 brown, loamy soil, medium fine-textured, moderately alkaline (pH 8)	- Round post-hole was found, approximately sized 20x20 cm, also extended 14-46 cm in the underlying levels.	- Archeological materials increased in this level and one vessel fragment exposed in the lower part.	
164-196	Features 4 (14-46)	10YR 4/3 brown, the sediments were quite similar in colour to those of upper levels.	- The size of the post-hole was similar to the Feature 3. - Sediments fitfully commingled with Nam Lang River sand.	- Occurrence of artefacts throughout, along with some recent items: iron and plastic rope.	

Table 2.4.1 Composition of the stratigraphic sequence of layer 1 in area 1 sector S23W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

Stratigraphic layers and depth in cm below datum.	**Levels and features (depth in cm from surface)**	**Soil characterisation**	**Type of feature**	**Archaeological materials**	**Soil samples analysis**
Layer 2		North profile			West profile
153-167, 158-169	1 (5-7)	10YR 4/3 brown, loamy soil (sand, clay, loam), moderately fine- textured, moderately alkaline (pH 8), organic matter (0.7-0.9).	- A part of small limestone fragments are derived from the roof of shelter. Sediments are highly compact, organic matter, along with some calcium carbonates.	- From the excavation, animal bone fragments, animal teeth, core tools, flakes, flake fragments, shells, potshards, beads and floral remains as well as some recent items: iron, cane, glass and bottle cap.	- 10YR 3/4 dark yellowish brown, organic matter 1.64, 67.48% sand, 19.71% silt and 12.81% clay. - Loamy soil (sandy, clayey, loamy) moderately fine-textured, moderately alkaline (pH 8).
155-170	2 (5-20)	10YR 4/4 brown.		- Ashes and charcoals in relation with Features 1 and 2.	
163-199	Feature 1 (13-39)	-7.5 YR 5/6 strong brown, loamy soil (sand, clay loam), moderately fine-textured, slightly alkaline (pH 7.5).	- Trace of fire pits found in Feature 1, combined with calcretes. Presence of dung and ashes in the surroundings near the rockshelter wall.	- Abundant calcretes in the Features 1 and 2.	
164-175	Feature 2 (14-25)	- Change in colour, mostly for the loamy component.			

Table 2.4.2a Composition of the stratigraphic sequence of layer 2 in area 1 sector S23W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

170-180 180-190	3 (20-30) 4 (30-40)	- 10YR 4/4 brown, loamy soil (sand, clay, loam), medium fine-textured, moderately alkaline (pH 8), highly compact.	- Gravel fragments densely combined with loamy soil. - Some limestone boulders and gravels scattered along the rockshelter wall, frequently in relation to calcretes. - From the Feature 1, the burnt sediments continued, especially mixed up with human skeletons.	- In the two levels, occurrence of animal bone fragments, animal teeth, core tools, flakes, flake fragments, pebbles & cobbles, shells, potsherds, calcrete and floral remains, mostly flake fragments and animal bones.	
190-200	5 (40-50)	10YR 4/4 brown, loamy soil (sand, clay, loam), medium fine- textured, moderately alkaline (pH 8).	- Large fragments of limestone, gravels and calcretes were exposed alongside the rockshelter wall with some hard sediments.	- Evidence of incomplete human skeletons. A few artefacts, while some calcrete textures were mixed up with faunal fragment remains.	

Table 2.4.2b Composition of the stratigraphic sequence of layer 2 in area 1 sector S23W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

Stratigraphic layers and depth in cm below datum.	**Levels and features (depth in cm from surface)**	**Soil characterisation**	**Type of feature**	**Archaeological materials**	**Soil samples analysis**
Layer 3		North profile			West profile
190-196	Feature 5 Burial 1 (40-50)	- 10YR 5/4 yellowish brown, loamy soil (sand, clay, loam), moderately fine-textured, moderately alkaline (pH 8).	- After cleaning of Feature 1, the calcretes and fire pit were exposed. Some faunal remains, small limestone and gravel fragments commingled in the surroundings of this feature.	- Occurrence of faunal remains with pebbles and calcretes. - At the bottom (190 cm dt.), less than 50 percent remains of a human skeleton (burial 1) with incomplete skull and mandible. - These archaeological remains might be associated with big stones pile, discovered on the upper part of the feature.	- 10YR 3/3 dark yellowish brown, organic matter 0.92, 62.47% sand, 24.96% silt and 12.48% clay. - Loamy soil (sandy, clay, loamy), moderately fine-textured, moderately alkaline (pH 8).
200-230	6-8 (50-80)	- 10YR 4/4 brown, loamy soil (sandy loam), moderately coarse-textured, moderately alkaline (pH 8) and low organic matter (0.2-0.5).	- Adjacent to the rockshelter wall abundant small limestone fragments, gravel fragments and calcretes, besides some turtle remains.	- Occurrence of some archaeological remains such as animal teeth, cobble tools, flakes, flake fragments and shells near the rockshelter wall. - Various human skeleton remains combined with flake fragments and calcretes.	- 10YR 4/3 dark yellowish brown, loamy soil (sand, loam), moderately coarse-textured, moderately alkaline (pH 8).

Table 2.4.3a Composition of the stratigraphic sequence of layer 3 in area 1 sector S23W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

230-258	9-10 (90-100)	- 7.5YR 4/4 brown and 7.5YR 4/6 strong brown, loamy soil (sand, clay, loam) moderately fine-textured, moderately alkaline (pH 8), highly compact.	- Throughout this level stone artefacts dramatically increasing near the rockshelter wall.	- Abundant material near the rockshelter wall, especially human skeletons and fragments.	
214-234	Feature 6 Burial 2 (64-94)	- 7.5 YR 5/4 brown, loamy soil (sand, clay, loam), moderately fine-textured, and moderately alkaline (pH 8).	- Five boulder limestones and gravels were arranged in a circle position. And when the stones had entirely been removed, many skeleton bones were found in these levels.	- From top to bottom, many parts of human skeleton: humerus, fibulas, scaphoid, ulna and radius gradually increasing in association with large-sized animal bones and cobble tools. - Small limestone chunks and skeleton fragments occurring around the limestone boulders on the circle area.	- 10YR 3/3 dark yellowish brown, organic matter 0.71, 65.35% sand, 19.8% silt and 14.85% clay. - Loamy soil (sand, clay, loam) moderately fine-textured, moderately alkaline (pH 8).
250-280	11-13 (80-130)	7.5 YR 4/4 brown, loamy soil (silty loam), moderately coarse-textured, moderately alkaline (pH 8).	- Small limestone fragments, gravel fragments and calcretes mostly scattered all along the rockshelter wall.	- Numerous stone artefacts and faunal remains increasing from top to bottom.	

Table 2.4.3b Composition of the stratigraphic sequence of layer 3 in area 1 sector S23W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

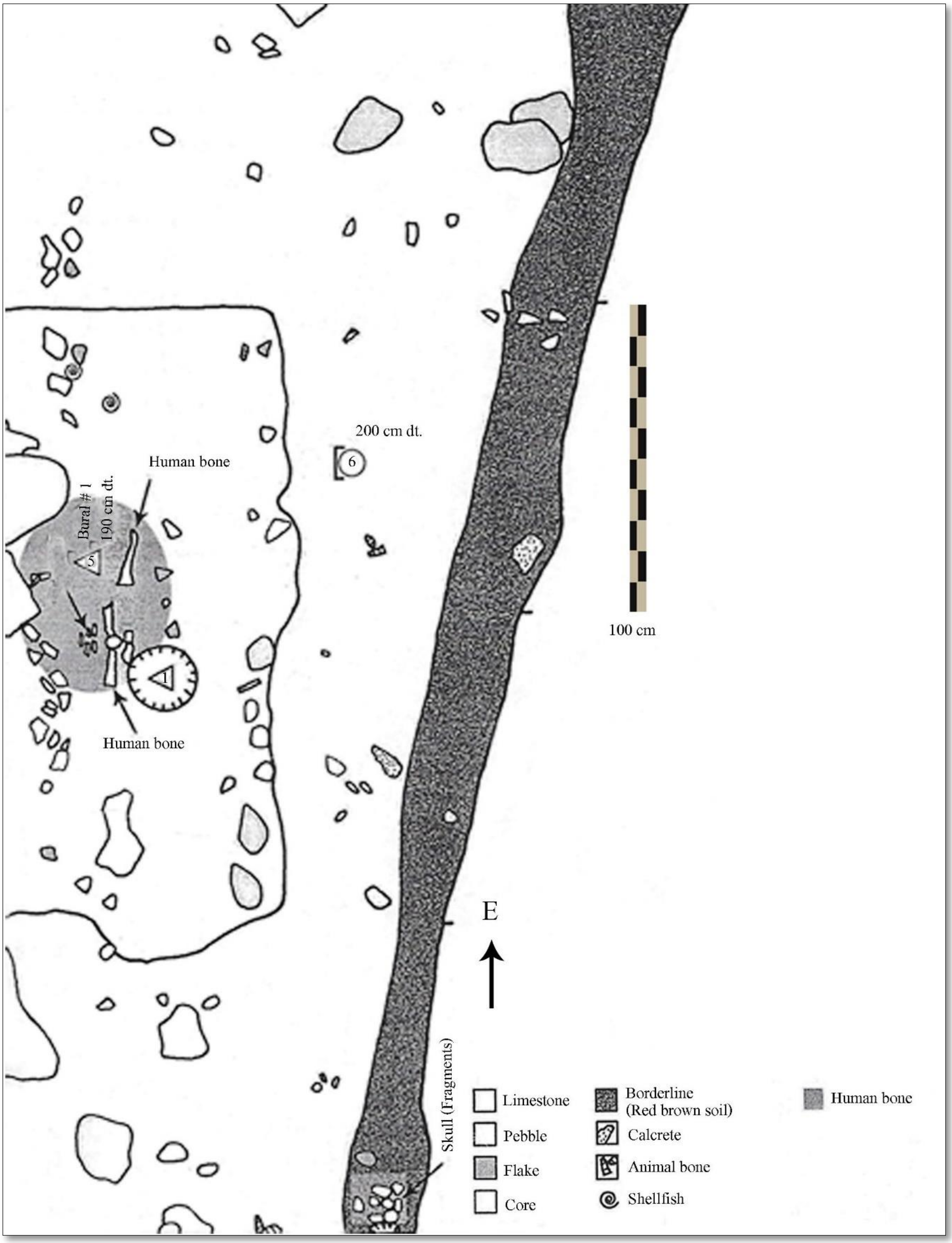


Figure 2.4.5 Plan of excavation, showing the position and extent of burial 1 of the archaeological material from the level 5 (190 cm dt.) in the area 1 sector S23W10 at Tham Lod Rockshelter (Source: Shoocongdej 2003, drawing by Krajaejun)

Stratigraphic layers and depth in cm below datum.	**Levels and features (depth in cm from surface)**	**Soil characterisation**	**Type of feature**	**Archaeological materials**	**Soil samples analysis**
Layer 4		North profile			West profile
280-330	14-18 (130-180)	7.5 YR 4/4 brown, 7.5 YR 3/4 brown, loamy soil (sandy loam), moderately coarse-textured, moderately alkaline (pH 8).	- Limestone fragments of different sizes were recovered, particularly in the central part.	- The cobble tools, flakes, fragments and manuports (cobbles and pebbles) besides calcretes and animal remains. - From the upper to lower levels, some animal fragments are mixed with the calcretes.	- 10YR 3/3 dark yellowish brown, organic matter 0.57, 47.48% sand, 30.72% silt and 21.80% clay. - Moderately alkaline (pH 8) and organic matters (0.2-04).
330-350	19-20 (180-200)	5 YR 4/3 reddish brown, clayey soil (sandy clay), fine textured, moderately alkaline (pH 8), compact. -The sediments rather changed in colour.	-In the central part, the small limestone fragments are mixed with clayey soil. -Boulder limestone fragments decreased.	- Cobble tools and flakes decreased, but the calcretes and faunal remains were very dense. - The large quantities of archeological remains gradually increase close to the rockshelter wall.	- 10YR 3/3 dark yellowish brown, OM. 0.57, 40.62% sand, 31.67% silt and 27.71% clay. - Moderately alkaline (pH 8).

Table 2.4.4 Composition of the stratigraphic sequence of layer 4 in area 1 sector S23W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

Figure 2.4.6 Plan of excavation, showing the distribution of the archaeological material from the level 16 (300 cm dt.) of the area 1 sector S23W10 at Tham Lod Rockshelter (Source: Shoocongdej 2003, drawing by Krajaejun)

Stratigraphic layers and depth in cm below datum.	Levels and features (depth in cm from surface)	Soil characterisation	Type of feature	Archaeological materials	Soil samples analysis
Layer 5		North profile			West profile
350-380	21-23 (210-230)	7.5YR 4/4 brown, 7.5 YR 3/4 dark brown, clayey soil (sandy clay), fine-textured, moderately alkaline (pH 8).	- The sediments were more compact and dense like wet soil, generally more sticky and plastic in nature. -The limestone fragments mixed up with clayey soil, along with calcretes.	- Numerous archaeological materials: shells and animal remains were less dense, near the rockshelter wall.	- 10YR 3/3 dark yellowish brown, organic matter 0.267, 38.68% sand, 32.64% silt and 28.68% clay - Moderately alkaline (pH 8).
380-430	24-28 (240-280)	5YR 4/3 reddish brown, 5YR 3/3 dark reddish brown, clayey soil (silty clay), fine-textured, moderately alkaline (pH 8) and organic matter (0.2-0.3).	- A large density of small limestone fragments and small pebbles were found near the rockshelter wall.	- Aimal bone fragments of various sizes were found near the rockshelter wall, besides flakes and flake fragments. - Archaeological assemblages increase, especially small flake fragments, micro-faunal remains and fire pits.	- 10 YR 3/3 dark yellowish brown, organic matter 0.37, 33.77% sand, 29.66% silt and 36.57% clay, moderately alkaline (pH 8).
430-440	29 (290)	7.5YR 3/4 dark brown, clayey soil, fine-textured and moderately alkaline (pH 8).			

Table 2.4.5 Composition of the stratigraphic sequence of layer 5 in area 1 sector S23W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

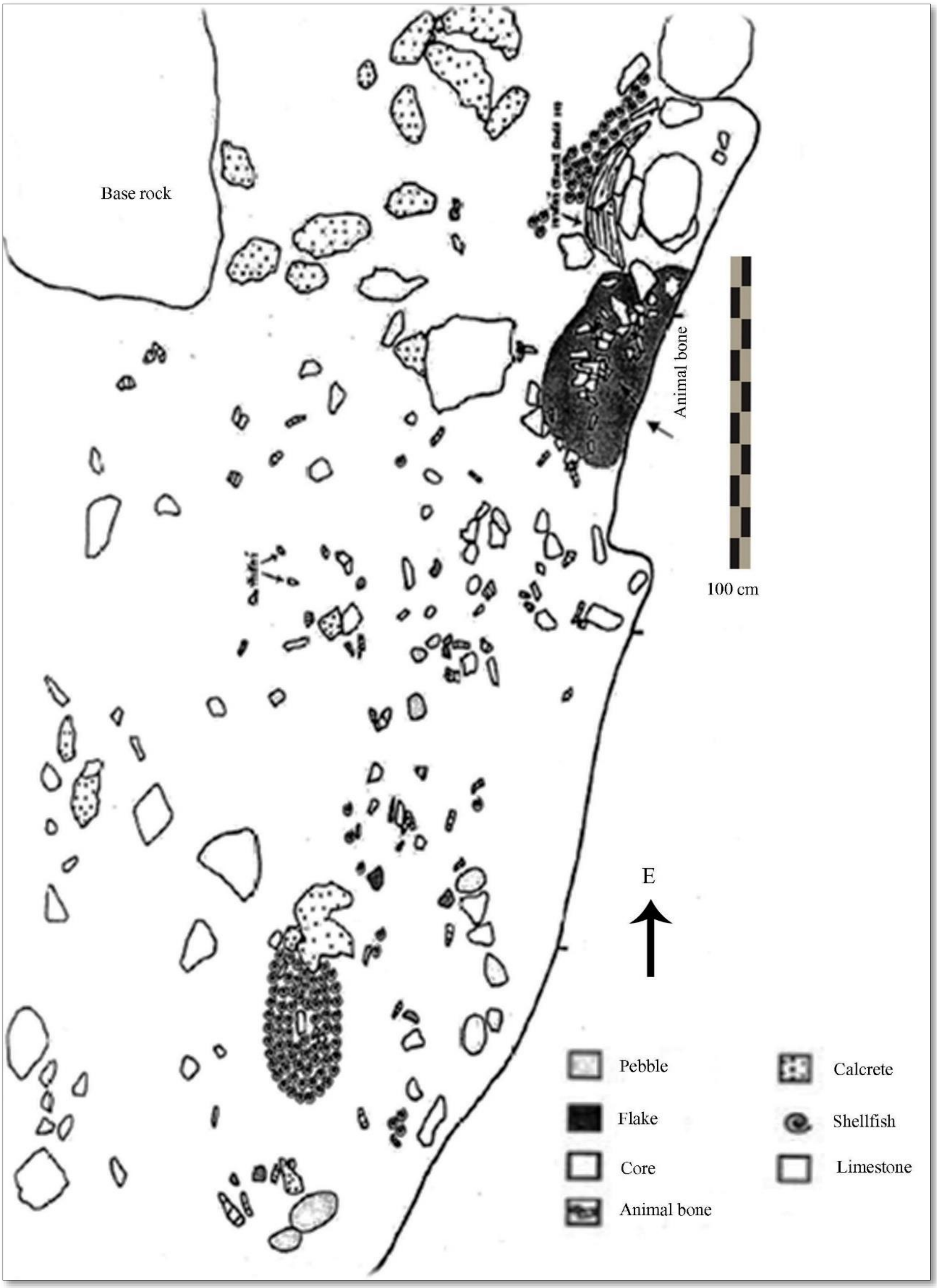


Figure 2.4.7 Plan of excavation, showing the distribution of the archaeological materials from the level 21 (350 cm dt.) of the area 1 sector S23W10 at Tham Lod Rockshelter (Source: Shoocongdej 2003, drawing by Krajaejun)

Stratigraphic layers and depth in cm below datum.	Levels and features (depth in cm from surface)	Soil characterisation	Type of feature	Archaeological materials	Soil samples analysis
Layer 6		North profile			West profile
440-460	30-31 (300-310)	- 7.5YR 5/3 brown, clayey soil (silty clay), fine-textured, moderately alkaline (pH 8) and organic (0.2-0.4). -The sediments are of changing colour and highly compact.	- Limestone fragments and some artefact assemblage are combined with clayey soil.	- There were lesser quantities of archaeological materials, and the numerous manuports (cobbles and pebbles) were scattered around this area. - Geologists hypothesized that the unmodified manuports and gravels from these levels might be flown from Lang River.	- 10 YR 3/4 dark yellowish brown, organic matter 0.19, 34.56% sand, 31.73% silt, 33.71% clay, fine-textured, moderately alkaline (pH 8).
Layer 7					
460-480	32-33 (320-330)	- 7.5YR 5/3 brown, clayey soil (silty clay), fine-textured and moderately alkaline (pH 8) and organic matters (0.13). - Sediments were periodically exposed in the upper levels.	- Gravel fragments were mixed up with clayey soil.	- No stone artefacts or faunal remains in these levels, only common gravels and pebbles were represented.	- 10 YR 3/4 - 4/3 dark yellowish brown, organic matter 0.13, 34.56% sand, 31.73% silt, 33.71%, moderately alkaline (pH 8).

Table 2.4.6 Composition of the stratigraphic sequence of layers 6 and 7 in area 1 sector S23W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

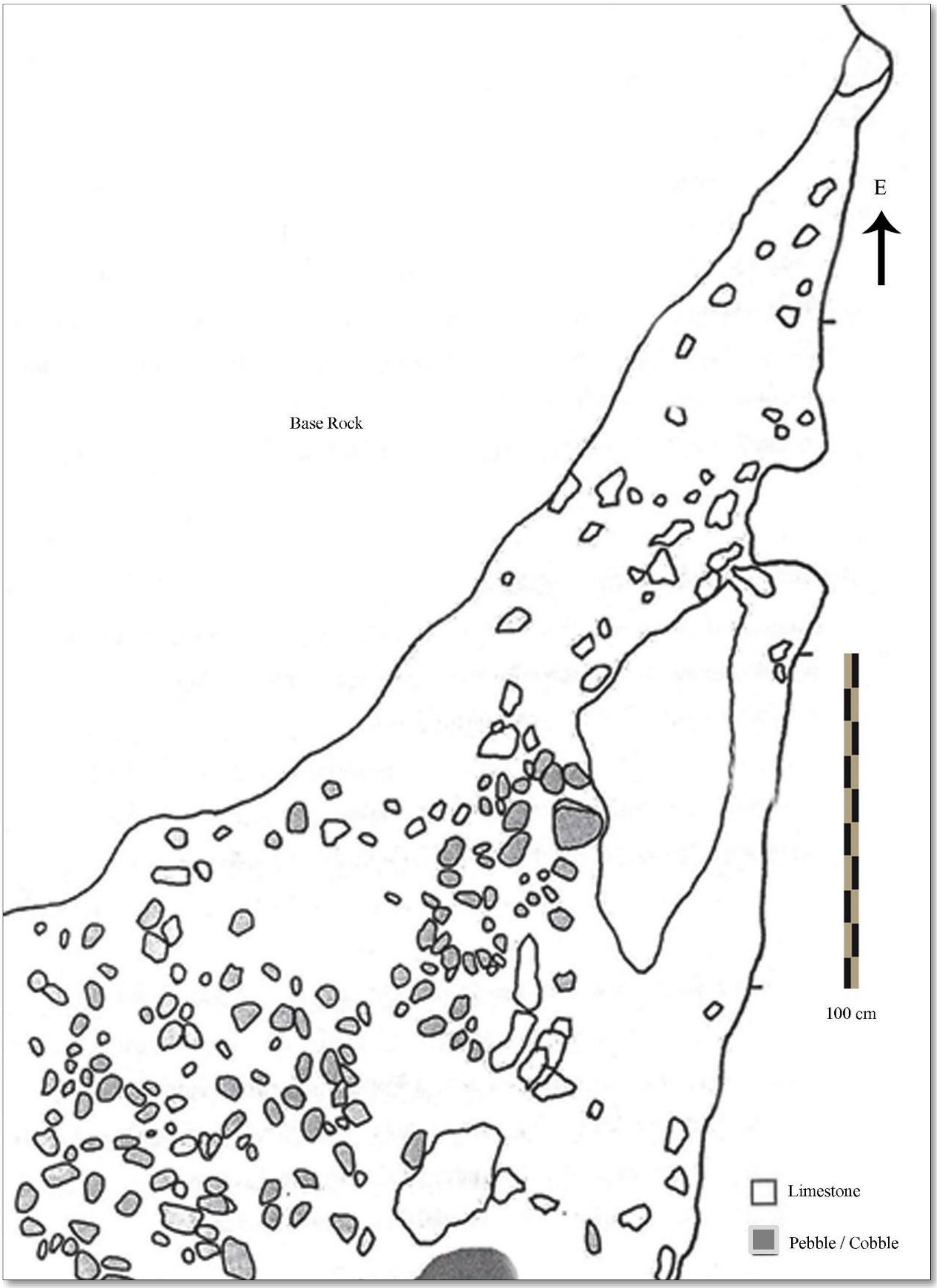


Figure 2.4.8 Plan of excavation, showing the distribution of the archaeological materials from the level 35 (490 cm dt.) of the area 1 sector S23W10 at Tham Lod Rockshelter (Source: Shoocongdej 2003, drawing by Krajaejun)

Stratigraphic layers and depth in cm below datum.	Levels and features (depth in cm from surface)	Soil characterisation	Type of feature	Archaeological materials	Soil samples analysis
Layer 8		North profile			West profile
480-570	34-45 (330-450)	5YR 4/3 reddish brown, 5YR 3/3, 3/4 dark reddish brown, clayey soil (silty clay), fine-textured, moderately alkaline (pH 8) and organic matter (0.1). - Sediments were quite similar in colour.	- Only gravel fragments were recovered and mostly combined with clayey soil.	- No archaeological remains in the lower levels.	-10 YR 4/3 dark yellowish brown, 25.79% sand, 26.72% silt, 47.49% clay, OM. 002, moderately alkaline (pH 8).

Table 2.4.7 Composition of the stratigraphic sequence of layer 8 in area 1 sector S23W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

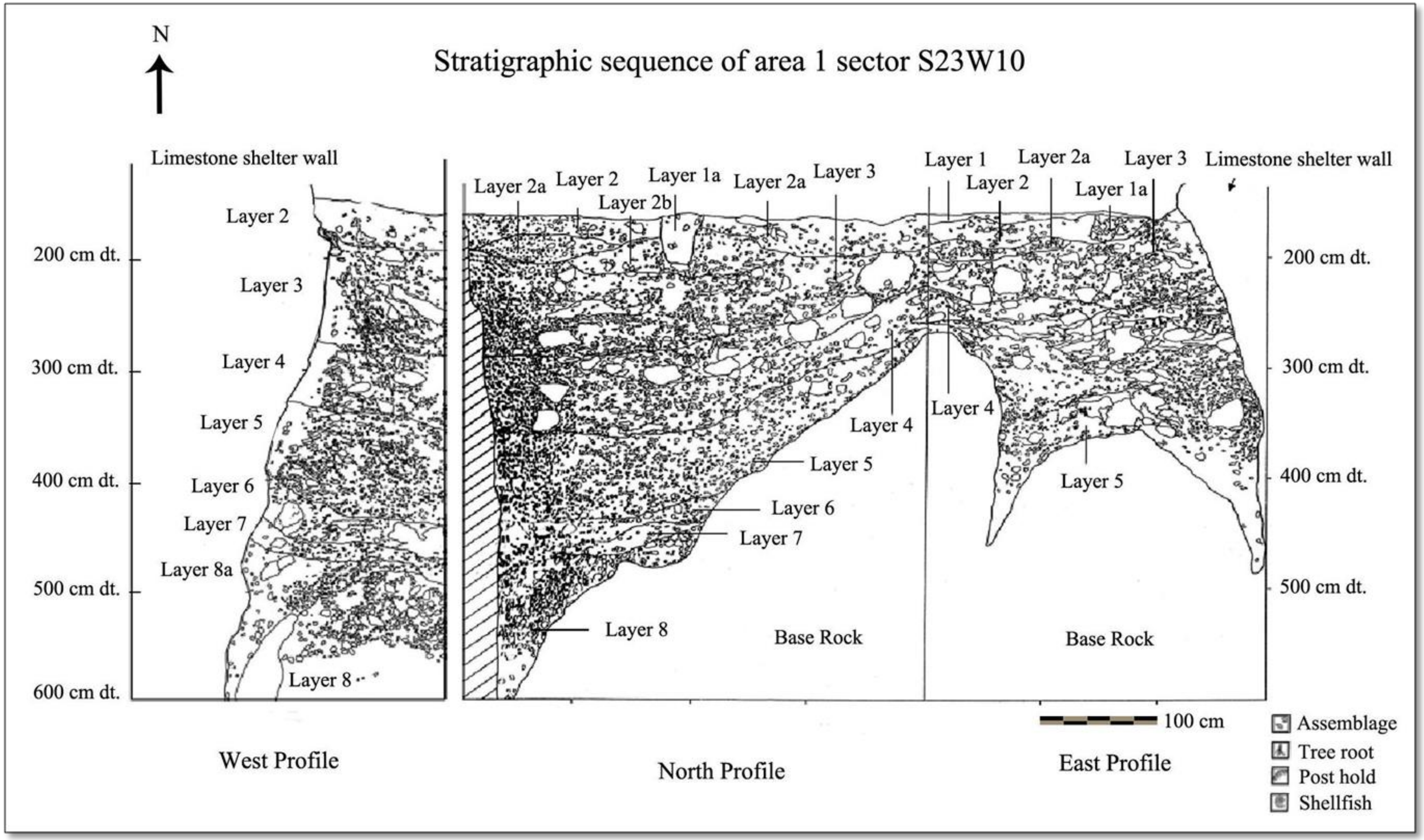


Figure 2.4.9 North, east and west profiles, showing the stratigraphic sequence of area 1 sector S23W10 at Tham Lod Rockshelter (Source: Shoocongdej 2003)

Figure 2.4.10 Photos of excavation of the area 1sector S23W10 at Tham Lod Rockshelter (Source: Khaokhiew 2004)

2.4.2 Stratigraphic sequence of area 2 sectors S21W10 and S20W10

The area 2 of Tham Lod Rockshelter is situated on a hill slope (hillock) near the area 1 (about 10 m ahead to the north). This area was interspersed by a large boulder of limestone rock fall, which was covered by sediments. The area 2, was exposed in three sectors of excavation: from south to north S21W10, Baulk S21W10 and S20W10. The natural stratigraphy consisted of 10 layers subdivided in 35 levels. The Pleistocene deposits correspond to layers 3 to 10 whose thickness ranges from 2.0 to 4.5 m. In this section, only the details on sectors S20W10 (SEQ 3-4) and S21W10 (SEQ 3-4) of area 2 are provided.

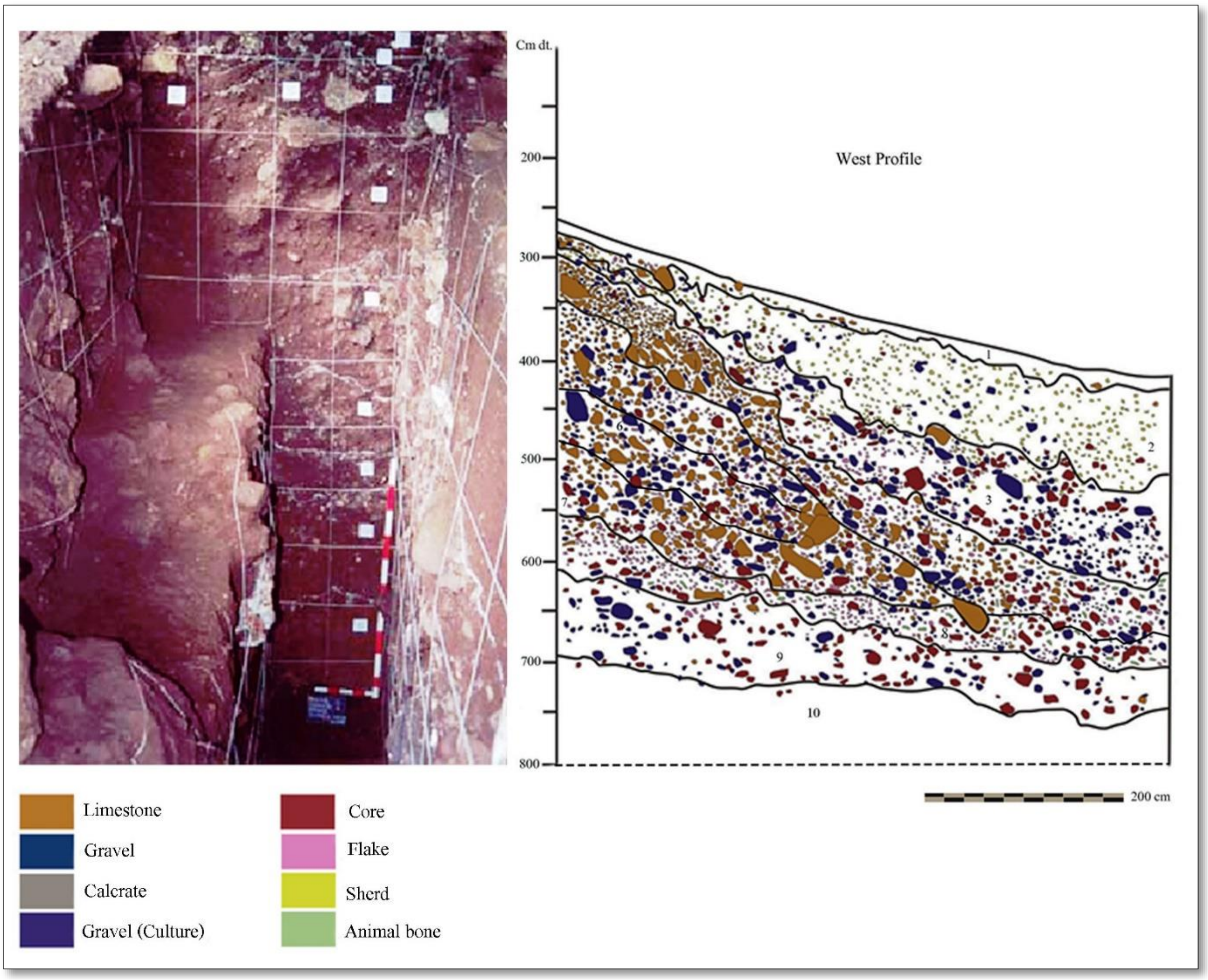


Figure 2.4.11 Stratigraphic sequence and vertical distribution of archaeological material in area 2 sector S21W10 at Tham Lod Rockshelter (Source: Khaokhiew 2004)

The natural stratigraphy of area 2 sector S21W10

Stratigraphic layers and depth in cm below datum.	Levels and features (depth in cm from surface)	Soil characterisation	Type of feature	Archaeological materials	Soil samples analysis
Layer 1					S21W10 (SEQ 3)
255-290 S-300 S-310	Surface (0-35) S-1 (0-45) S-2	- 7.5YR 3/2 dark brown, loamy soil (sand, loam), moderately coarse-textured, slightly alkaline (pH 7.5) and moderately compact.	- Some tree roots and small limestone fragments were scattered around the area. - The broken fragments were chipped off in a white dust, and few ashes are combined with loamy soil.	- Numerous archaeological materials were exposed: animal bones and fragments, animal teeth, stone fragments, flakes, pebbles, shells and potsherds, along with other recent items like glasses, beads, iron fragments and ammunition.	- The top soil (5-10 cm), 10YR 3/2 dark brown, organic matter: 3.02, moderately alkaline (pH 8).
290-300	1 (35-45)	7.5YR 3/2 dark brown. - Organic matter: 3.0, loamy soil (clay, loam, slightly sticky and plastic).	- Small limestone fragments gradually increase, besides ashes, potsherds and small gravel fragments, mixed up with loamy soil.	- Cobble tools, flakes and flake fragments, pebbles, shells, animal teeth and beads dramatically increase. Occurrence of burnt bone fragments and potsherds in these levels. - There were more densities of archeological materials in the lower levels.	

Table 2.4.8 Composition of the stratigraphic sequence of layer 1 in area 2 sector S21W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

Stratigraphic layers and depth in cm below datum.	Levels and features (depth in cm from surface)	Soil characterisation	Type of feature	Archaeological materials	Soil samples analysis
Layer 2					S21W10 (SEQ 3)
300-310 310-320	2 (45-55) 3 (55-65)	- 5YR3/2 dark reddish brown, loamy soil (sand, clay, loam), medium-textured, neutral (pH 7). - Organic matter: 0.8-2.5, less compact, more pores in loamy soil. -5YR3/2 dark reddish brown, loamy soil (sandy loam), moderately coarse -textured, neutral (pH 7).	- Tree roots and small limestone fragments were sporadically discovered, including some broken fragments. - A few ashes are combined with loamy soil. - There were large quantities of small and broken limestone fragments, chipped off in the white dusts.	- Large quantities of animal bone fragments, of which some are burnt, increased in these levels. - Other archaeological materials like cobble tools, flakes, manuports (pebbles and cobbles), shells, potshards, beads and some recent metal items: glasses, nails and iron fragments were found.	- 10 YR 3/2 very dark brown, 30.04% sand, 20.7% silt, 51.27 % clay. - Organic matter: 2.54, moderately alkaline (pH 8).

Table 2.4.9 Composition of the stratigraphic sequence of layer 2 in area 2 sector S21W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

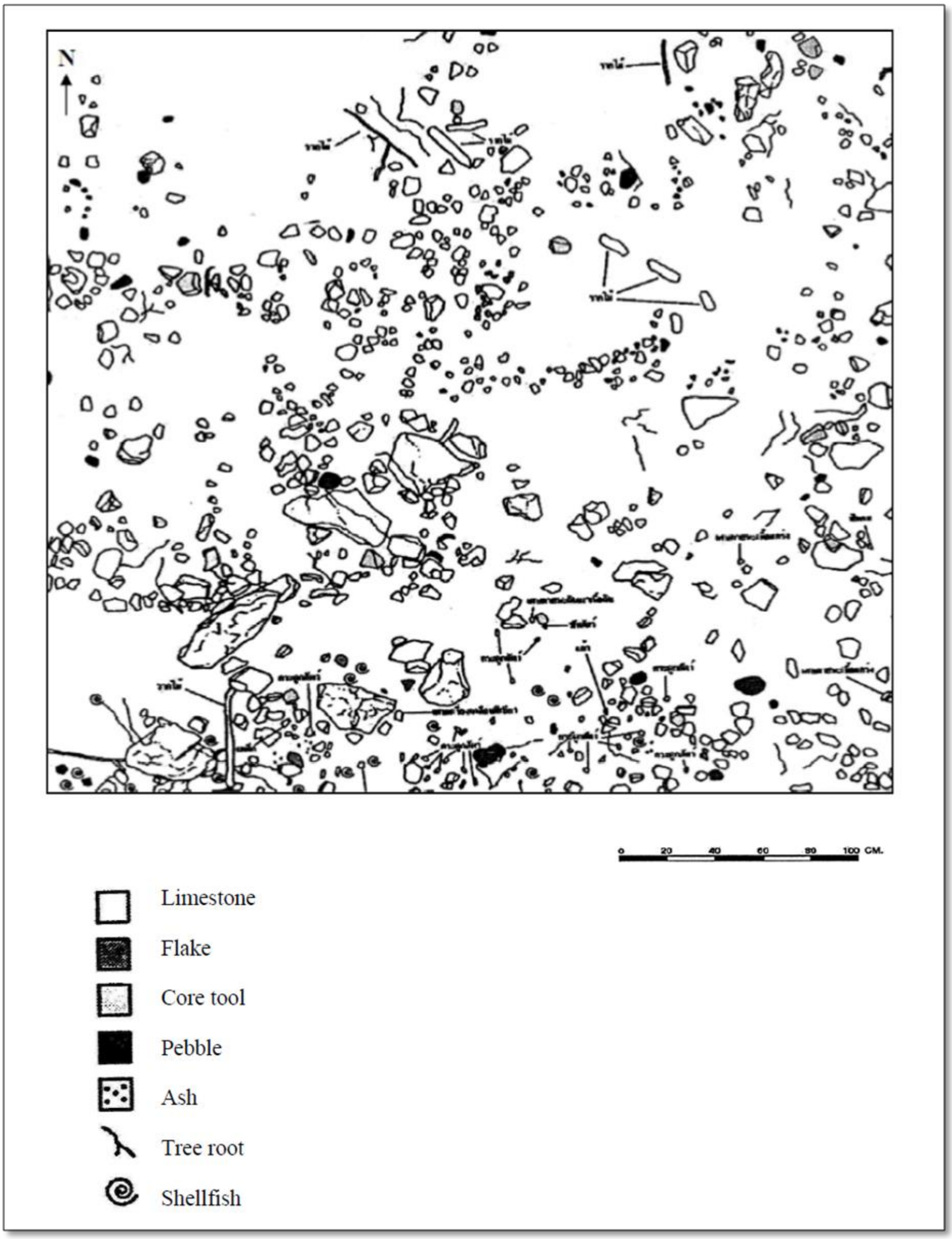


Figure 2.4.12 Plan of excavation, showing the distribution of the archaeological material from the stratigraphic layer 2 (280-400 cm dt.) of area 2 sector S21W10 at Tham Lod Rockshelter (Source: Shoocongdej 2003, drawing by Krajaejun)

Stratigraphic layers and depth in cm below datum.	Levels and features (depth in cm from surface)	Soil characterisation	Type of feature	Archaeological materials	Soil samples analysis
Layer 3					S21W10 (SEQ 3)
320-330	4 (65-75)	- 7.5YR 3/2 dark brown, loamy soil (sandy loam), moderately coarse-textured, neutral (pH 7). - 5 YR 2.5/2 dark reddish brown, clayey soil (sandy clay), fine-textured, neutral (pH 7). - The sediments were of darker colour (reddish brown) in the lower levels.	- The large-sized limestone fragments were more common. - Chipped white dusts of limestone fragments were abundant and some ashes were mixed up with loamy soil.	- Archaeological materials: cobble tools, flakes, fragments, unmodified manuports, potsherds and animal bone fragments are more common in the upper levels. - Animal bone fragments including burnt specimens were discovered in large quantity. - Potsherds and limestone fragments were also recovered.	-10YR 3/2 very dark grayish brown, organic matter: 0.12, strongly alkaline (pH 8.5), 9.85% sand, 21.75% silt, 68.36% clay.
330-340	5 (75-85)	- 5 YR 3/4 dark reddish brown, loamy soil (sandy loam), moderately coarse-textured, neutral (pH 7), and highly compact.	- Some small limestone fragments and ashes were associated with loamy soil.	- There were more cobble tools than flakes, fragments and unmodified manuports. Large and medium - sized animal bones were recovered, besides some potshards, shells and one human tooth.	- 10YR 3/2 very dark grayish brown, organic matter: 0.12, strongly alkaline (pH 8.5) 33.68% sand, 22.76 % silt, 43.59% clay.

Table 2.4.10 Composition of the stratigraphic sequence of layer 3 in area 2 sector S21W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

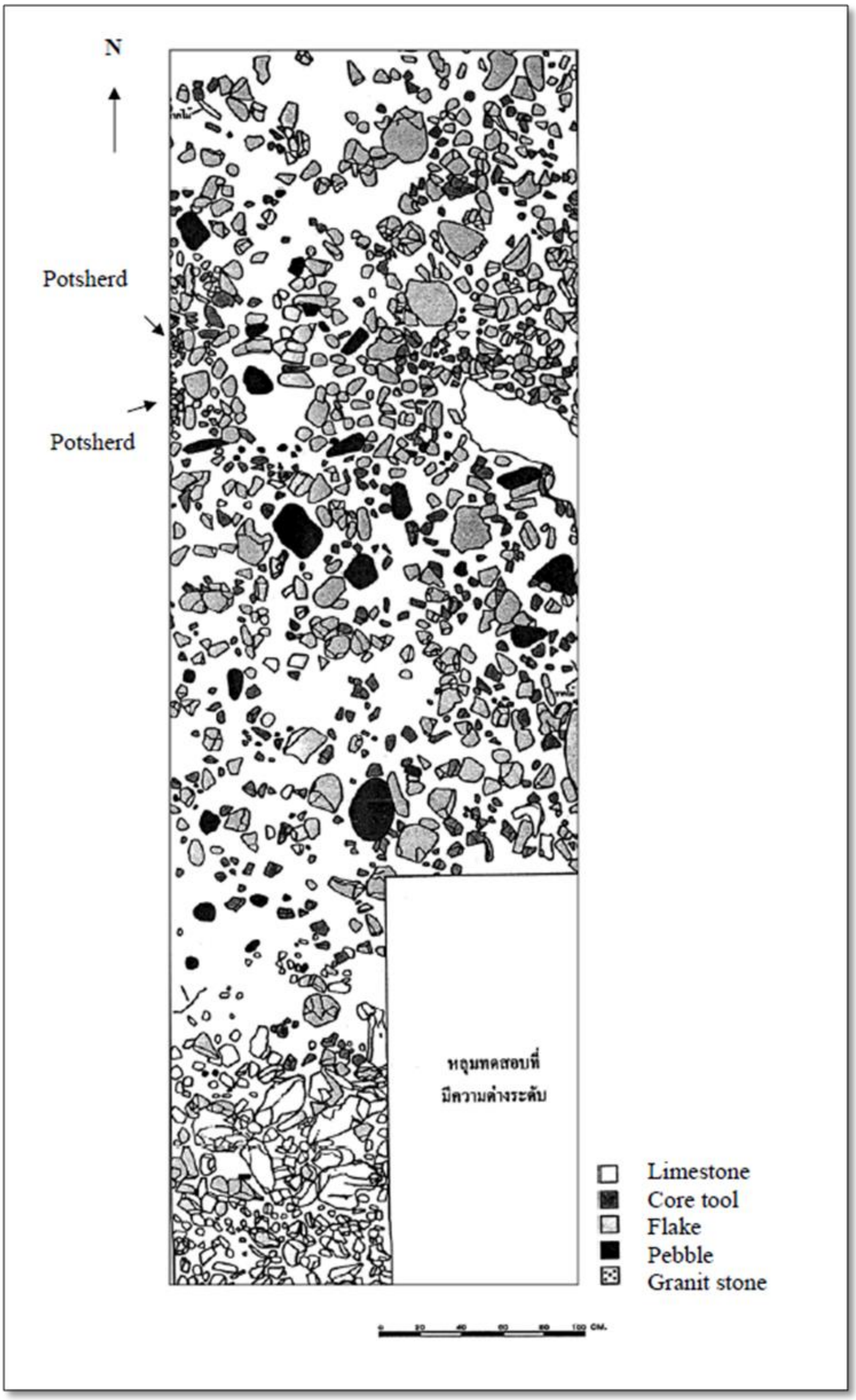


Figure 2.4.13 Plan of excavation, showing the distribution of the archaeological material from the stratigraphic layer 3 (315-539 cm dt.) of area 2 sectors S21W10 (NEQ 1-4, SEQ 1-3), Baulk S21W10 (N/E1-2) and S20W10 (SEQ 3-4) at Tham Lod Rockshelter (Source: Shoocongdej 2003, drawing by Krajaejun)

Stratigraphic layers and depth in cm below datum.	Levels and features (depth in cm from surface)	Soil characterisation	Type of feature	Archaeological materials	Soil samples analysis
Layer 4					S21W10 (SEQ 3)
340-360	6-7 (85-105)	- 5YR 3/2 dark reddish brown, loamy soil (sandy loam), moderately coarse - textured, neutral (pH 7).	- Small limestone fragments were spread over the sediments. - Small limestone fragments and small tree roots were visible.	- There were low densities of archaeological materials in these levels. - Only 3 cobble tools, a few flakes and animal bone fragments were exposed, with some potshards, limestone fragments and shellfishes.	- 33.68% sand, 22.76 % silt, 43.59% clay.
360-370	8 (105-115)	- 5YR 3/2 dark reddish brown.	- A large limestone block was laid down on the floor. - Small limestone fragments were chipped off in the white dust on a wide area.	- Large quantity of cobble tools, flakes, fragments and manuports were discovered, along with some broken fragments of animal bones, shells, and iron fragments.	
370- 400	9-11 (115-145)	- 5YR 3/2 dark reddish brown.	- Calcium carbonate and animal bone remains are mixed with loamy soil.	- Cobble tools, flakes, flake fragments and manuports (cobbles and pebbles) gradually increase in these levels. Some animal bone fragments and potsherds were also found.	

Table 2.4.11 Composition of the stratigraphic sequence of layer 4 in area 2 sector S21W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

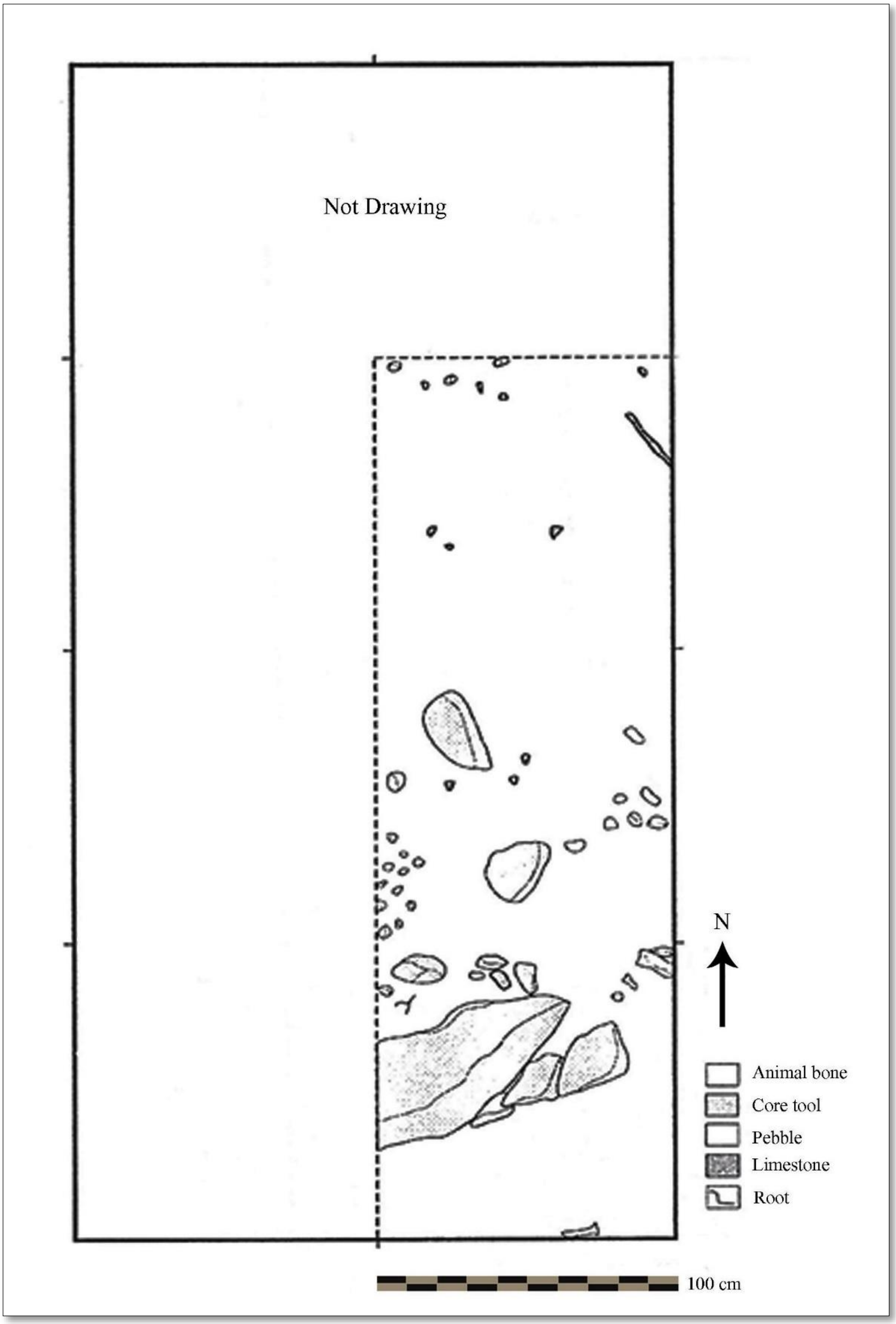


Figure 2.4.14 Plane of excavation, showing the surface of level 9 (370 cm dt.) of area 2 sector S21W10 at Tham Lod Rockshelter (Source: Shoocongdej 2003, drawing by Krajaejun)

Stratigraphic layers and depth in cm below datum.	Levels and features (depth in cm from surface)	Soil characterisation	Type of feature	Archaeological materials	Soil samples analysis
Layer 5					S21W10 (SEQ 3)
400-420	12-13 (145-165)	- 5YR 4/3 reddish brown, loamy soil (sand, loam), moderately coarse-textured, slightly acid (pH 6.5) and moderately compact.	-The small limestone fragments, animal bone fragments and ashes were scattered and mixed up with loamy soil. -Several animal bones were decayed in the sediments.	- Cobble tools, flakes and manuports (pebbles and cobbles) were more than in other levels. - Large quantities of faunal remains, some of them burnt, were largely associated with carbonates. - Some potsherds and shells also occurred.	- 10YR 3/2 dark grayish brow, strongly alkaline (PH 8.5), organic matter 0.14, 28.68% sand, 23.78% silt, 47.56% clay.
420-450	14-16 (165-205)	- 5YR 4/4 reddish brown, loamy soil (clay, loam), moderately fine-textured, slightly alkaline (pH 7.5)	- A limestone boulder was discovered in the lower levels; after removing it a new level immediately appeared.	- The archaeological materials were recovered as in the upper levels, including animal bone fragments and large-sized animal remains. - Decayed bone fragments were quite common, besides shells, horn and animal teeth. No potsherds.	- 10 YR 3/4 dark yellowish brown, organic matter 0.18, slightly alkaline (PH 8), 25.65% sand, 21.75% silt, 52.4% clay.
450-470	17-18 (205-225)	- The sediments were quite compact.	- From these levels, small limestone fragments increased in density.	- Archeological materials gradually increase, mainly animal bone remains.	

Table 2.4.12 Composition of the stratigraphic sequence of layer 5 in area 2 sector S21W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

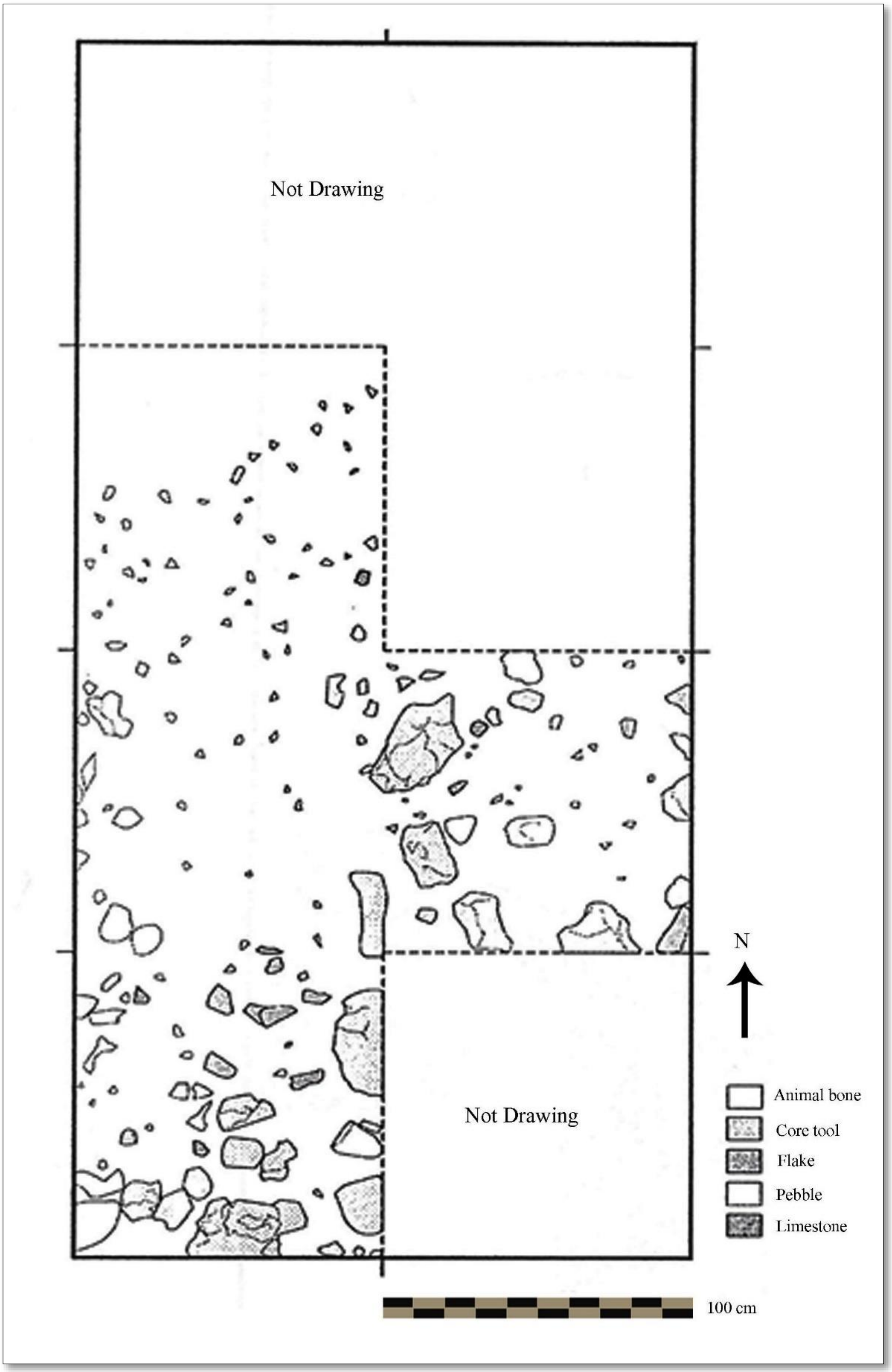


Figure 2.4.15 Plane of excavation, showing the surface of level 20 (480 cm dt.) of area 2 sector S21W10 at Tham Lod Rockshelter (Source: Shoocongdej 2003, drawing by Krajaejun)

Stratigraphic layers and depth in cm below datum.	Levels and features (depth in cm from surface)	Soil characterisation	Type of feature	Archaeological materials	Soil samples analysis
Layer 6					S21W10 (SEQ 3)
470-490 490-520	19-20 (225-245) 21-22 (245-275)	- 5YR 4/4 reddish brown, loamy soil (silty loam), medium-textured, moderately alkaline (pH 8). - 5YR 4/4 reddish brown, clayey soil (silty clay), fine-textured, moderately alkaline (pH 8). - The sediments were similar to upper levels.	- Small limestone fragments slightly decrease in quantity in comparison to the above level, and some of these were chipped off in a white dust. - Small limestone fragments and charcoals were often recovered, as well as some animal bone fragments, chipped off in a white dust.	- Cobble tools, flakes, fragments and manuports (cobbles and pebbles) were exposed. The shells, animal bones and burnt fragments increase. - The number of cobble tools, flakes, fragments and manuports increased and animal bones fragments, sometimes burnt, were noticeable in these levels.	- 10 YR 3/4 dark yellowish brown, organic matter 0.29, slightly alkaline (pH 8), 34.7% sand, 18.81% silt, 46.5% clay.
Layer 7					
520-540 560-580	23 (275-295) 24-25 (295-355)	- 5YR4/4 reddish brown and moderately compact. - 5YR3/2 dark reddish brown, loamy soil (silty loam), medium-textured, moderately alkaline (pH 8) and moderately compact.	- Small limestone fragments were exposed from the upper levels.	- The archaeological materials were similar to upper levels. - Large quantities of cobble tools were discovered, besides flakes, fragments, hammers, manuports, animal teeth and animal bone fragments. - Various animal sizes were represented.	- 10 YR 3/4 dark yellowish brown, organic matter 0.26, slightly alkaline (pH 8), 32.7% sand, 20.08% silt, 44.52% clay.

Table 2.4.13 Composition of the stratigraphic sequence of layers 6 and 7 in area 2 sector S21W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

Stratigraphic layers and depth in cm below datum.	Levels and features (depth in cm from surface)	Soil characterisation	Type of feature	Archaeological materials	Soil samples analysis
Layer 8					S21W10 (SEQ 3)
580-600	26 (335-355)	- 5YR3/3 dark reddish brown, loamy soil (silt, clay, loam), moderately fine-textured, moderately alkaline (pH 8), highly compact with frequent pores.	- Some limestone boulders were partially arranged. The limestone fragments were chipped off in a white dust.	- After removing boulder limestone fragments, large quantities of artefacts were discovered: more than 20 unifacial tools, along with flakes and animal bone remains. - Other archeological materials such as cobble tools, hammers, fragments, animal teeth and bones were sporadically exposed.	- 10 YR 3/4 dark yellowish brown, organic matter 0.67, slightly alkaline (pH 8), 34.43% sand, 19.87% silt, 45.7% clay.
600-620	600-620	- 5YR3/3 dark reddish brown, organic matter: 0.4-0.5.	- White dust from limestone fragments was often found from the upper to lower levels.	- Very few stone artefacts were present; only large animal bone fragments with some decayed animal fragments.	
Layer 9					
640-680	29-30 (395-435)	- 5YR 4/3 dark reddish brown, clayey soil (sand, clay), fine-textured, slightly alkaline (pH 7.5), organic matter: 0.4-0.5, and highly compact.	- Very few limestone fragments in these levels.	- Amount of archaeological materials dramatically decreases.	- 10 YR 3/4 dark yellowish brown, organic matter 0.52, slightly alkaline (pH 8), 34.57% sand, 16.85% silt, 48.58% clay.
680-700	31 (455-475)	- 5YR3/3 dark reddish brown, loamy soil (sand, clay, loam), moderately fine-textured, slightly alkaline (pH 7.5).	- Some limestone fragments were found from the upper levels.	- Archeological remains sharply decrease from upper to lower levels.	

Table 2.4.14 Composition of the stratigraphic sequence of layers 8 and 9 in area 2 sector S21W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

Stratigraphic layers and depth in cm below datum.	**Levels and features (depth in cm from surface)**	**Soil characterisation**	**Type of feature**	**Archaeological materials**	**Soil samples analysis**
Layer 10					S21W10 (SEQ 3)
700-720	32 (455-475)	- 7.5YR4/4 brown, loamy soil (sandy loam), moderately coarse-textured, slightly alkaline (pH 7.5), organic matter: 0.1, highly compact with more pores.	- Only a few small limestone fragments were exposed in these levels.	- Low quantities of stone artefacts were discovered, and most of them were made from sandstones. - Some large-sized animal teeth and floral remains also occurred.	- 10 YR 3/4 dark yellowish brown, organic matter 0.09, slightly acid (pH 6.5), 28.67% sand, 15.85% silt, 53.27% clay.

Table 2.4.15 Composition of the stratigraphic sequence of layer 10 in area 2 sector S21W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

The natural stratigraphy of area 2 sector S20W10

Stratigraphic layers and depth in cm below datum.	Levels and features (depth in cm from surface)	Soil characterisation	Type of feature	Archaeological materials	Soil samples analysis
Layer 1					S20W10 (SEQ 3)
440-460	16-17 (0-13)	7.5YR 3/2 dark brown, loamy soil (sandy loam, moderately coarse-textured, moderately acid (pH 6), highly compact, organic matter: 0.2-0.3.	- The tree roots and small limestone fragments were sporadically scattered in these levels; pores. were common	- The archaeological assemblage mainly rich in flake fragments, along with manuports (cobbles and pebbles), potsherds, animal bone fragments and one piece of polished stone.	- 10 YR 2/2 very dark brown, organic matter: 3.57, slightly alkaline (pH 8), 32.04% sand, 17.94% silt, 48.26% clay.
Layer 2					
460-480	18-19 (23-43)	-5YR 3/2 dark reddish brown, loamy soil (clay loam), moderately fine-textured, moderately acid (pH 6).	- High density of small limestone fragments was noticed as well as some tree roots, often from the upper to the lower levels.	- Stone artefacts increased and the potsherds were many.	- 10 YR 3/2 dark brown, organic matter: 2.43, slightly alkaline (pH 8), 30.04% sand, 17.94% silt, 50.26% clay.
480-490	20-21 (43-63)	- 5YR 3/2 dark reddish brown, moderately fine-textured, moderately acid (pH 6) and organic matter: 0.8-1.2.	- In the lower levels, limestone fragments of different sizes were recovered, particularly of larger sizes.	- The archaeological materials increased a lot in these levels. Out of these, there were cobble tools, flakes and manuports, potsherds and small animal bone fragments.	
500-540	22-23 (63-103)	- 5YR 3/2 dark reddish brown, loamy soil (clay loam), moderately fine-textured, moderately acid (pH 6) and highly compact.		- A few potsherds and small-sized animal bones were discovered. - Amount of archaeological materials was slightly higher in the lower levels.	

Table 2.4.16 Composition of the stratigraphic sequence of layers 1 and 2 in area 2 sector S20W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

Stratigraphic layers and depth in cm below datum.	Levels and features (depth in cm from surface)	Soil characterisation	Type of feature	Archaeological materials	Soil samples analysis
Layer 3					S20W10 (SEQ 3)
540-580	24-25 (103-143)	- 5YR 3/3 dark reddish brown, loamy soil (sand, clay, loam), moderately fine-textured, moderately acid (pH 6).	- Small limestone fragments were recovered in a density larger than that in the upper layers.	- The archaeological assemblage: big fragments, unifacial tools, flakes, manuports (cobbles and pebbles) were in large quantities, along with small animal fragments. - Only 2 fragments of potsherds were found in these levels.	-10 YR 3/3 dark brown, organic matter: 0.8, slightly alkaline (pH 8), 26.04% sand, 15.94% silt, 58.26% clay.
580-620	26-27 (143-183)	- 5YR 3/3 dark reddish brown, loamy soil (clay, loam), moderately fine-textured, moderately acid (pH 6); organic matter: 0.8.	- Small limestone fragments rather decrease, and some of these were chipped off in a white dust.	- Numerous artefacts were associated with upper levels.	- 10 YR 3/3 dark brown, organic matter: 0.46, slightly alkaline (pH 8), 28.66% sand, 23.78% silt, 47.56% clay.
620-640	28 (183-203)	-5YR 3/3 dark reddish brown, loamy soil, moderately acid (pH 6).	- Small limestone fragments, ashes and animal burnt fragments were scattered in these levels.	- Archeological materials gradually increase in these levels, mainly animal bone fragments.	

Table 2.4.17 Composition of the stratigraphic sequence of layer 3 in area 2 sector S20W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

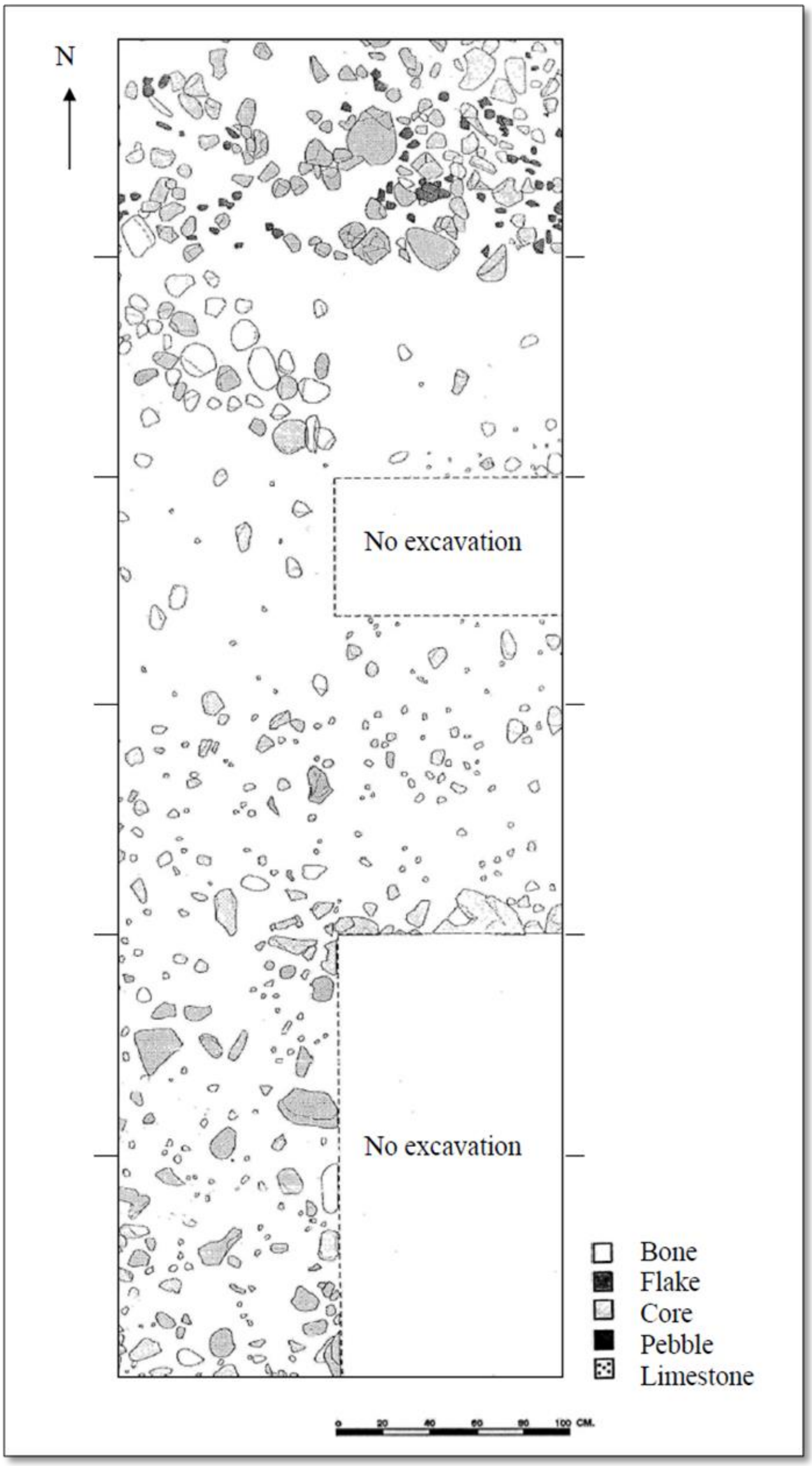


Figure 2.4.16 Plan of excavation, showing the distribution of the archaeological material from the level 24 (540 cm dt.) of area 2 sectors S21W10, Baulk S21W10 and S20W10 at Tham Lod Rockshelter (Source: Shoocongdej 2003, drawing by Krajaejun)

Stratigraphic layers and depth in cm below datum.	Levels and features (depth in cm from surface)	Soil characterisation	Type of feature	Archaeological materials	Soil samples analysis
Layer 4					S20W10 (SEQ 3)
640-680	29-30 (203-243)	- 5YR 3/2 dark reddish brown, loamy soil (sandy loam), moderately coarse-textured, highly compact, moderately acid (pH 6), organic matter: 0.4-0.5	- White dust from small limestone fragments was noticed. - Some small limestone fragments and animal bone fragments are mixed with the sediments.	- Large quantity of big fragments and cobble tools was present, as well as flakes, flake fragments and manuports (pebbles and cobbles). The archeological materials were similar to upper levels. Large-sized animal remains and animal teeth were found in the upper levels.	- 10 YR 3/3 dark brown, organic matter 0.52, slightly alkaline (pH 8), 34.57% sand, 16.85% silt, 48.58% clay.
680-700	31 (263-283)	- 5YR 3/2 dark reddish brown, loamy soil (sandy loam), moderately coarse-textured, neutral (pH 7).	- The white dusts gradually increase from the upper to the lower levels, including common pore spaces in the loamy soil.	- The archaeological remains decreased in the lower levels. There were more evidences of the large-sized animal remains.	
Layer 8					
700-720	32 (263-283)	- 5YR 3/3 dark reddish brown, loamy soil (sandy loam), moderately coarse -textured, slightly acid (pH 6.5), organic matter: 0.4-0.5). - The sediments were dark reddish brown in some parts of these levels.	- Some white dust was released by the limestone fragments.	- Stone artefacts were comprised of big fragments, flakes, manuports (cobbles and pebbles) and hammerstones, along with a few cobble tools. - The animal bone fragments dramatically decreased from the upper to lower levels.	- 10 YR 3/3 dark brown, organic matter: 0.38, slightly alkaline (pH 8), 30.57% sand, 18.85% silt, 48.46% clay.

Table 2.4.18 Composition of the stratigraphic sequence of layers 4 and 8 in area 2 sector S20W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

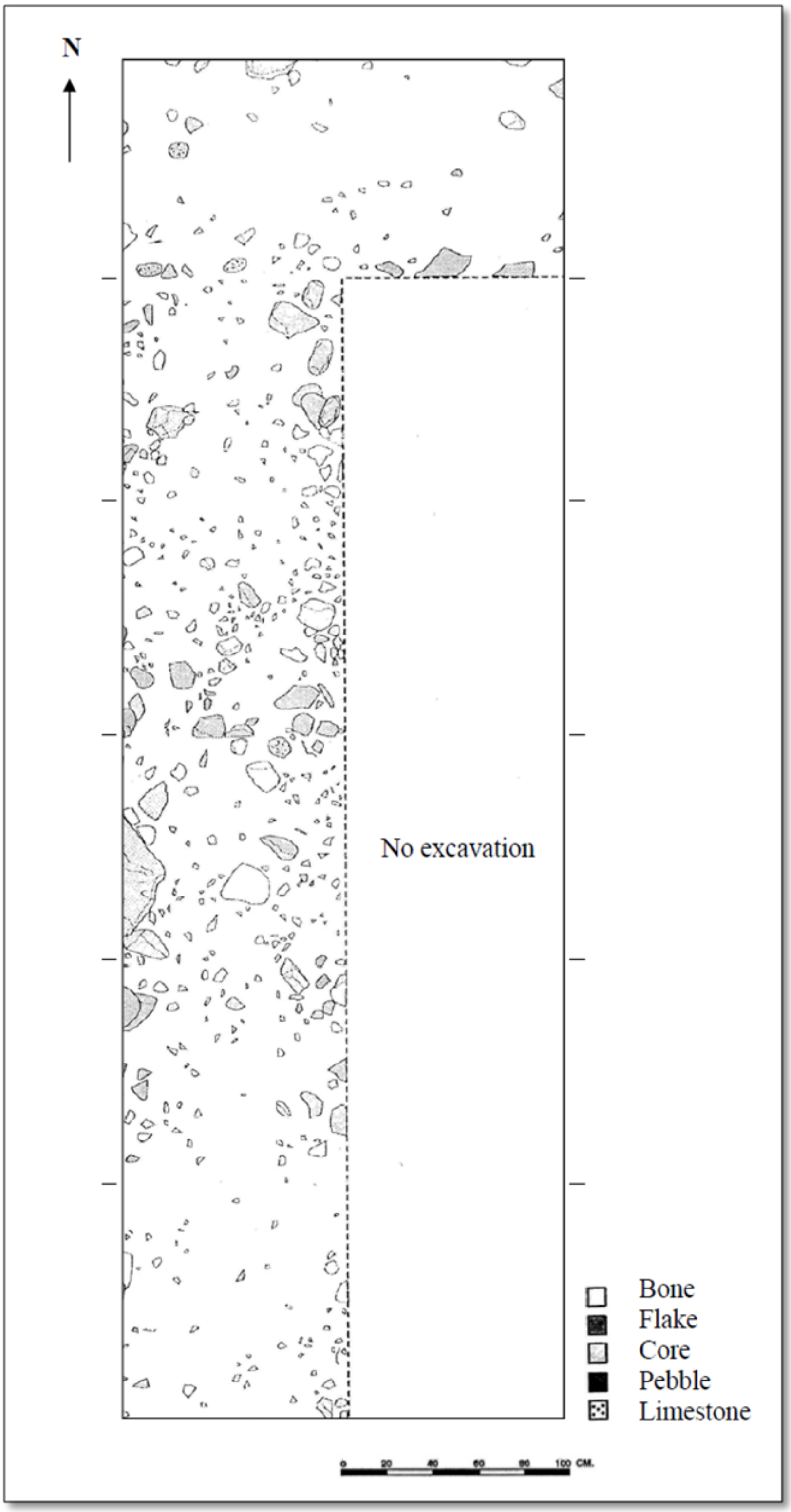


Figure 2.4.17 Plan of excavation, showing the distribution of the archaeological material from the level 29 (640 cm dt.) of area 2 sectors S21W10, Baulk S21W10 and S20W10 at Tham Lod Rockshelter (Source: Shoocongdej 2003, drawing by Krajaejun)

Stratigraphic layers and depth in cm below datum.	Levels and features (depth in cm from surface)	Soil characterisation	Type of feature	Archaeological materials	Soil samples analysis
Layer 9					S20W10 (SEQ 3)
720-740	33 (283-303)	- 5YR 4/3 dark reddish brown, highly compact, neutral (pH 7), organic matter: 0.1. - The sediments were dark reddish brown like upper levels.	- A few limestone fragments were exposed; occurrence of some pores.	- Stone assemblage sharply decreased in these levels: cobble tools, flakes and manuports (cobbles and pebbles). - Reversely animal bone remains were numerous.	- 10 YR 3/3 dark brown, organic matter: 0.34, slightly alkaline (pH 8), 28.66% sand, 23.78% silt, 47.56% clay.
Layer 10					
740-780	33-34 (303-343)	7.5YR 4/4 dark reddish brown, clayey soil (sand, clay), fine-textured, slightly alkaline (pH 7.5) and highly compact.	- Some small limestone fragments, less than (3 cm), were recovered, including some common pores.	- Only big fragments, flake fragments and manuports (cobble and pebble) were found in the lower levels.	- 10 YR 3/3 dark brown, organic matter: 0.12, slightly alkaline (pH 8), 28.67% sand, 15.58% silt, 55.47% clay.

Table 2.4.19 Composition of the stratigraphic sequence of layers 9 and 10 in area 2 sector S20W10 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

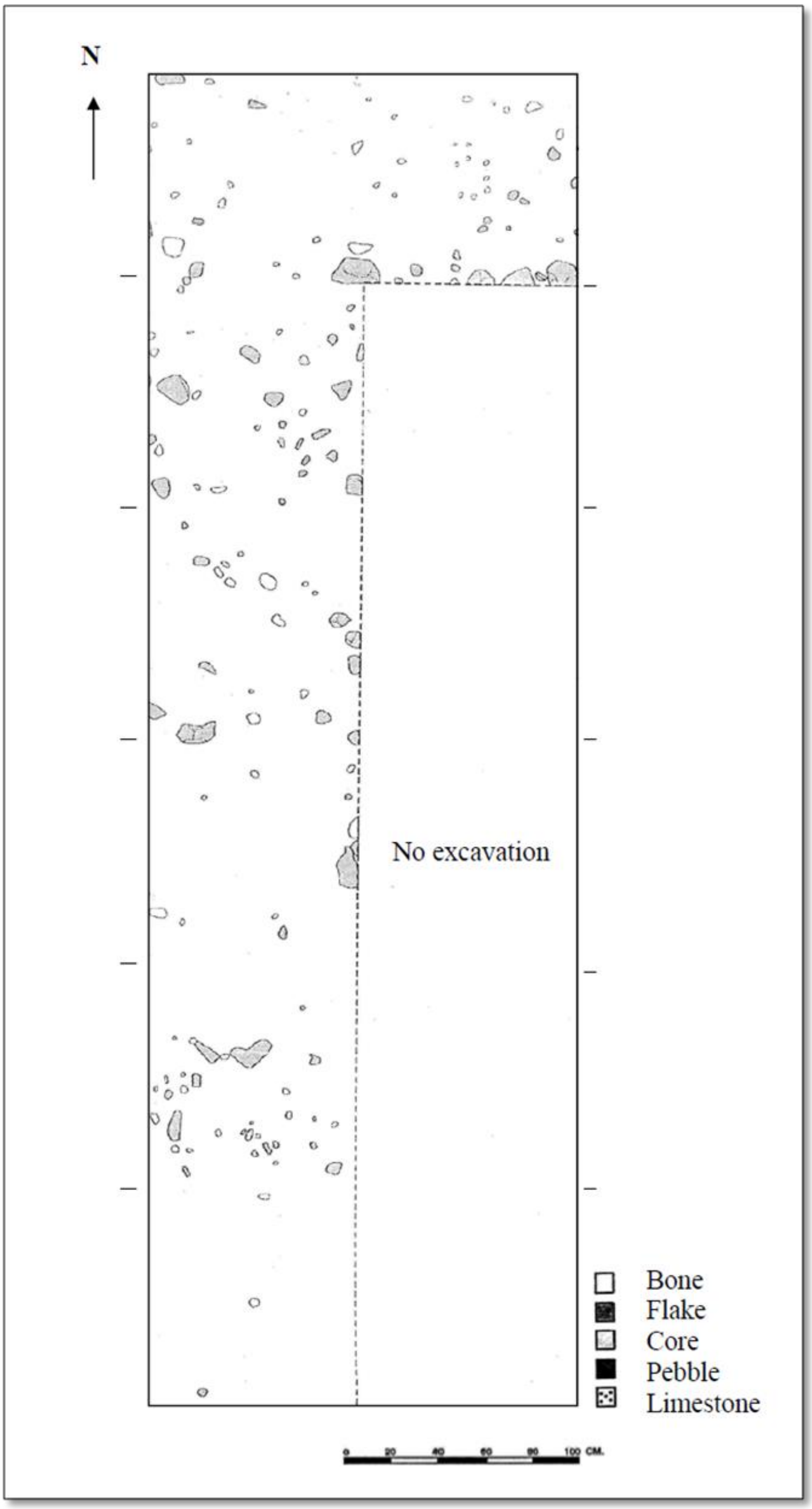


Figure 2.4.18 Plan of excavation, showing the distribution of the archaeological material from the level 34 (740 cm dt.) of area 2 sectors S21W10, Baulk S21W10 and S20W10 at Tham Lod Rockshelter (Source: Shoocongdej 2003, drawing by Krajaejun)

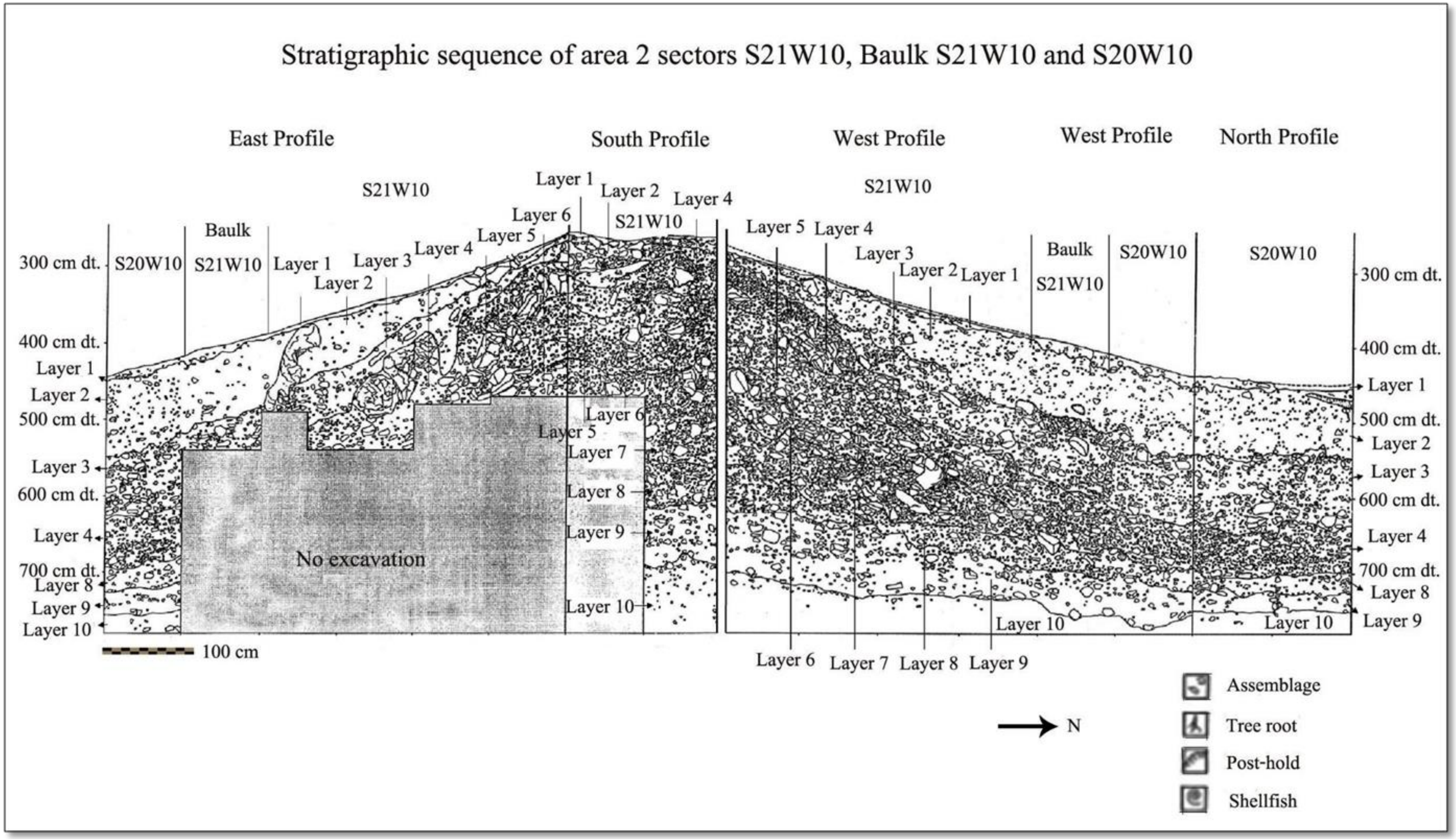


Figure 2.4.19 The four profiles of the trench in area 2 showing the stratigraphic sequence of sectors S20W10, Baulk S21W10 and S21W10 at Tham Lod Rockshelter (Source: Shoocongdej 2003)

Figure 2.4.20 Photos of excavation of area 2 at Tham Lod Rockshelter (Source: Khaokhiew 2004)

2.4.3 Stratigraphic sequence of area 3

The area 3 is situated down slope near the Tham Lod Rockshelter (about 15 m ahead to the north). Portions of the high terrace of Lang River are mixed up with the deposits from area 2. This area was composed of three sectors: S20W9, Baulk S20W9 and S19W9. In the east profile, the natural stratigraphy of sector S20W9, comprised of 19 levels, could be divided into 4 layers **(figure 2.4.21)**.

The Pleistocene deposits are represented by layers 3 and 4, which are about 2.0 to 2.5 m thick. From the layer 4, a TL date was processed and provided a result around 35,782 ± 266 BP (Akita-TL1). This date is the oldest one obtained from Tham Lod Rockshelter (Shoocongdej 2003, 2004, 2005, 2006, 2007; Khaokhiew 2004). The stratigraphic layers in the sector S20W9 are presented below:

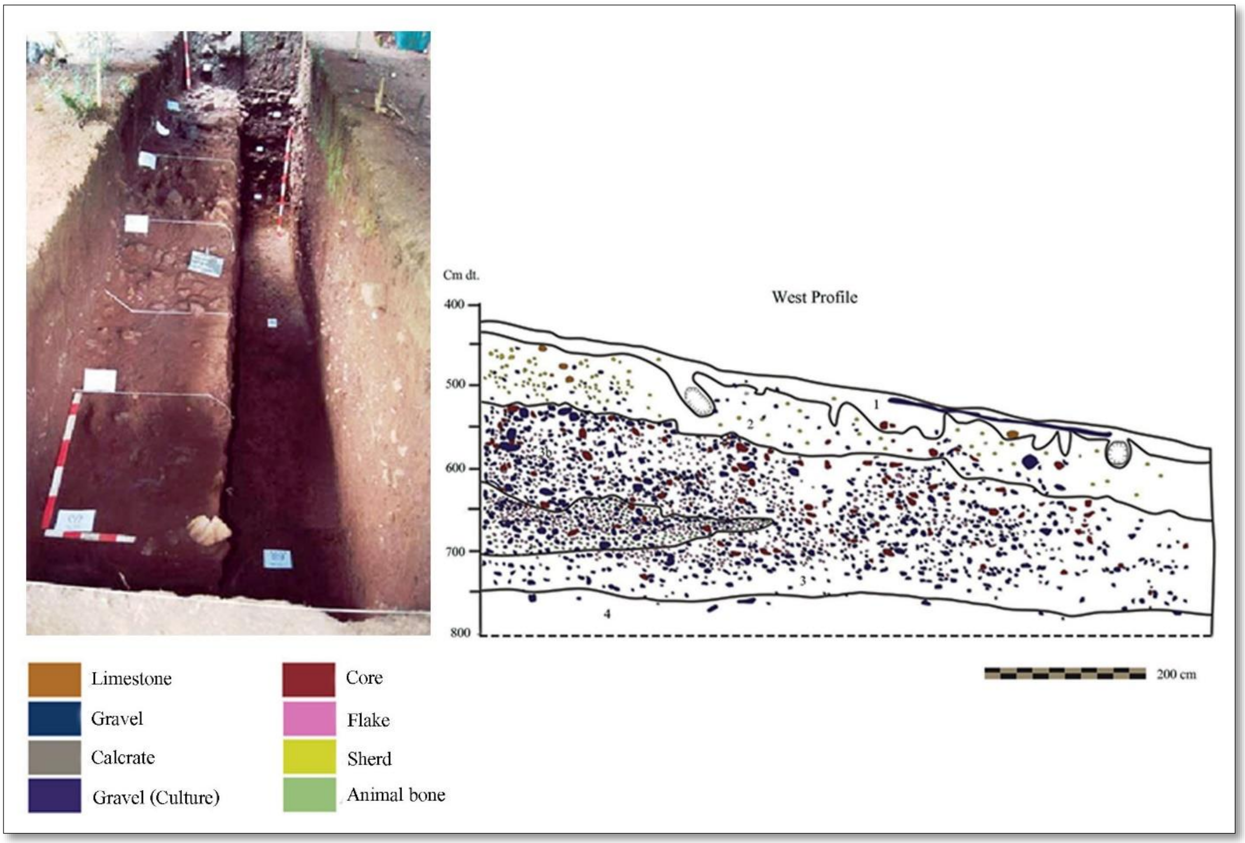


Figure 2.4.21 Stratigraphic sequence and vertical distribution of the archaeological material in area 3 at Tham Lod Rockshelter (Source: Khaokhiew 2004)

The natural stratigraphy of area 3 sector S20W9

Stratigraphic layers and depth in cm below datum.	Levels and features (depth in cm from surface)	Soil characterisation	Type of feature	Archaeological materials	Soil samples analysis
Layer 1					S20W9 (SWQ 3)
425-440	Surface (0-15)	- 7.5YR 2.5/2 very dark brown, loamy soil (clay, loam), moderately fine-textured and moderately compact, slightly acid (pH 6.5), organic matter: 1-1.7.	- Tree roots, leafs, animal burrows are present. - From surface small limestone gravel fragments were scattered in the top levels; pores were common.	- Cobble tools, flakes, animal bones and potsherds were mainly found in these levels.	- 10 YR 3/3 dark brown, organic matter 0.17, neutral (pH 7), 34.35% sand, 21.82% silt, 43.63% clay.
Layer 2					
440-460	1-2 (15-35)	- 7.5YR 3/4 dark brown, loamy soil (clay, loam), moderately fine-textured, slightly acid (pH 6.5), organic matter: 0.8-1.2.	- Always tree roots and animal burrows. - Small limestone fragments and decayed animal remains increased in these levels, as well as pores.	- Artefacts, especially cobble tools, flakes, flake fragments and manuports (pebbles and cobbles) were found in good quantities, along with decayed faunal remains.	- 10 YR 3/4 dark yellowish brown, organic matter: 2.02, neutral (pH 7), 26.63% sand, 14.87% silt, 56.5% clay.
460-500	3-4 (35-75)	7.5YR 3/4 dark brown, clayey soil (sand, clay), fine-textured.	- The density of limestone fragments was similar to upper levels.	- Cobble tools, flakes, manuports, animal bones and potsherds were abundant.	
500-540	5-6 (75-115)	- 7.5YR 3/4 dark brown, organic matter: 0.8-1.2.	- Occurrence of tree roots and animal burrows.	- Limestone fragments and small animal bone remains were scattered in these levels.	

Table 2.4.20 Composition of the stratigraphic sequence of layers 1 and 2 in area 3 sector S20W9 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

Stratigraphic layers and depth in cm below datum.	Levels and features (depth in cm from surface)	Soil characterisation	Type of feature	Archaeological materials	Soil samples analysis
Layer 3					S20W9 (SWQ 3)
540-560	7 (115-135)	-5YR 3/4 dark brown, clayey soil (sandy clay), fine-textured, slightly acid (pH 6.5) and compact.	- Small limestone and gravel fragments were found in the upper levels.	- Cobble tools, flakes, animal bones and potsherds were found.	- 10 YR 3/4 dark brown, organic matter: 0.7, neutral (pH 7), 27.53% sand, 17.66% silt, 55.73% clay.
560-580	8 (135-155)	- 2.5 YR 2.5/4 dark reddish brown, fine-textured, organic matter: 0.4-0.5, slightly acid (pH 6.5).	- Some limestone fragments were mixed up with animal bone fragments and most of them were settled in the same pile of limestone.	- No potsherds were discovered in these levels.	

Table 2.4.21 Composition of the stratigraphic sequence of layer 3 in area 3 sector S20W9 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

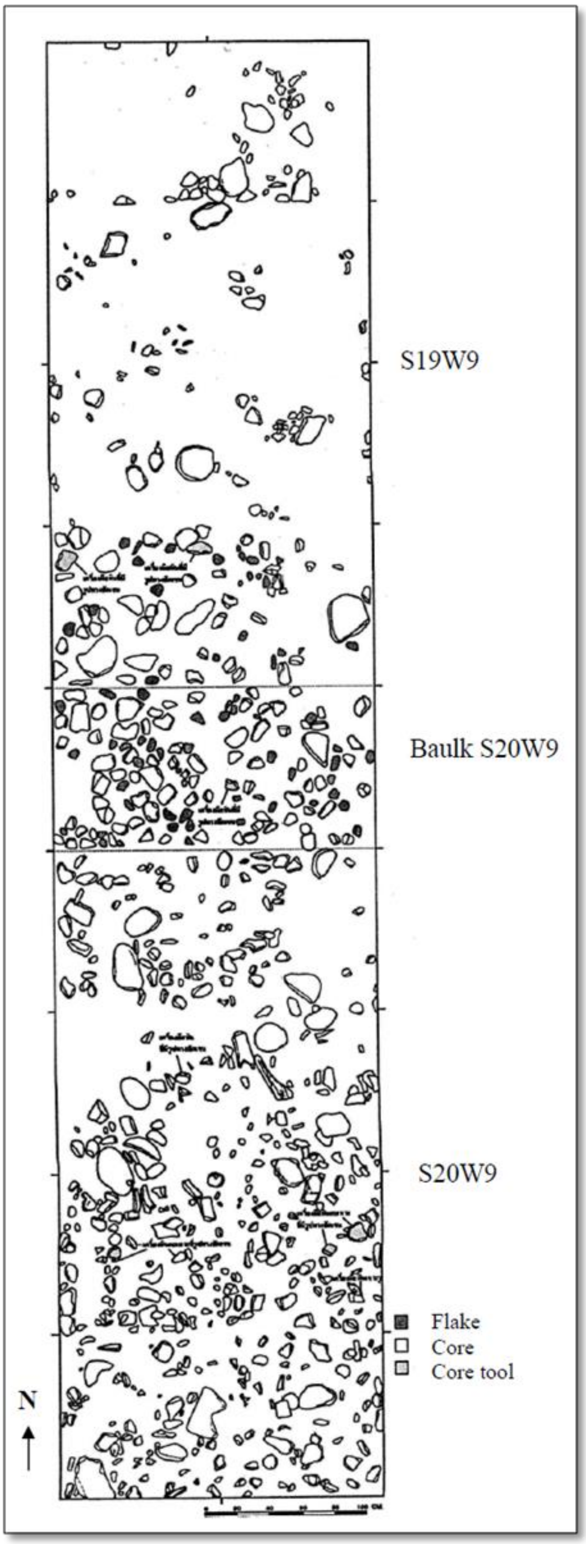


Figure 2.4.22 Plan of excavation, showing the distribution of the archaeological material from the level 7 (540 cm dt.) of area 3 at Tham Lod Rockshelter (Source: Shoocongdej 2003, drawing by Krajaejun)

Stratigraphic layers and depth in cm below datum.	Levels and features (depth in cm from surface)	Soil characterisation	Type of feature	Archaeological materials	Soil samples analysis
Layer 3a					S20W9 (SWQ 3)
580-600 (Upper level)	9 (155-175)	- 2.5 YR 2.5/4 dark reddish brown, clayey soil (sand, clay), fine-textured, slightly acid (pH 6.5), organic matter: 0.4-0.5.	- Different sizes of gravel fragments were found mixed with animal bone fragments in the same pile of gravels.	- Only cobble tools, flakes, fragments and animal bones were represented.	- 10 YR 3/3 dark brown, organic matter: 0.46, slightly acid (PH 6.5), 24.46% sand, 19.88% silt, 55.66% clay.
600-620	10 (175-195)	2.5 YR 2.5/3 dark reddish brown, clayey soil (sand, clay), fine-textured, highly compact, slightly acid (pH 6.5).	- Gravel fragments were quite similar to upper levels.	- Most of archaeological materials gradually decreased in these levels.	
620-640	11 (195-215)	- 2.5 YR 2.5/3 dark reddish brown, clayey soil (sandy clay), fine-textured, slightly acid (pH 6.5), organic matter: 0.4-0.5.	- High density of gravel fragments in these levels mixed in the same pile, besides traces of fire pits.	- Cobble tools, flakes, flake fragments and animal remains were still present. There were more animal bone fragments than in upper levels.	
680-700 (Lower level)	14 (255-275)	- 5YR 3/4 dark reddish brown, clayey soil (sandy clay), fine-textured, slightly acid (pH 6.5).	- Very few gravel fragments and animal bone fragments.	- Archaeological assemblage was similar to the upper levels.	
700-720	15 (275-295)	2.5 YR 2.5/3 dark reddish brown, clayey soil (sandy clay), fine-textured, moderately acid (pH 6).		- Most of archaeological materials were exposed such as cobble tools, flakes and animal remains.	

Table 2.4.22a Composition of the stratigraphic sequence of layer 3a in area 3 sector S20W9 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

720-740	16 (295-315)	5YR 3/2 dark reddish brown, clayey soil (sandy clay), fine-textured, slightly acid (pH 6.5).	- There were less gravel fragments than in the upper levels.	- A few animal bone fragments were recorded.	- 10 YR 3/2 very dark brown, organic matter: 0.55, slightly acid (pH 6.5), 28.61% sand, 17.85% silt, 53.54% clay.
Layer 3b					S20W9 (SWQ 3)
640-660	12 (215-235)	- 2.5 YR 2.5/3 dark reddish brown, clayey soil (sandy clay), fine-textured, slightly acid (pH 6.5), organic matter: 0.4-0.5.	- High density of gravel fragments in these levels mixed in the same pile, besides traces of fire pits.	- Cobble tools, flakes, flake fragments and animal remains were exposed. There were more animal bone fragments.	- 10 YR 3/3 dark brown, organic matter: 0.57, slightly acid (PH 6.5), 24.46% sand, 19.81% silt, 55.66% clay.
660-680	13 (235-225)	- 2.5 YR 2.5/3 dark reddish brown, clayey soil (sandy clay), fine-textured, slightly acid (pH 6.5).	- Gravel fragments were mixed with animal bone fragments like upper levels.	- Archaeological materials were similar to the upper levels.	
Layer 4					
740-800	17-19 (315-375)	5YR 3/2 dark reddish brown, clayey soil (sandy clay), fine-textured, slightly acid (pH 6.5), organic matter 0.2 and highly compact.	- Amount of gravel fragments was considerably less in these levels. - Gravel fragments of different sizes were mixed with the sediments; occurrence of pores in the soil.	- Cobble tools and flake were recorded in lesser quantity than in the upper levels. - No activities related to human occupation in the lower levels.	-10 YR 3/6 dark yellowish brown, organic matter: 0.06, slightly acid (pH 6.5), 30.69% sand, 15.84% silt, 53.47% clay.

Table 2.4.22b Composition of the stratigraphic sequence of layers 3a, 3b and 4 in area 3 sector S20W9 at Tham Lod Rockshelter (Sources: Shoocongdej 2003; Khaokhiew 2004)

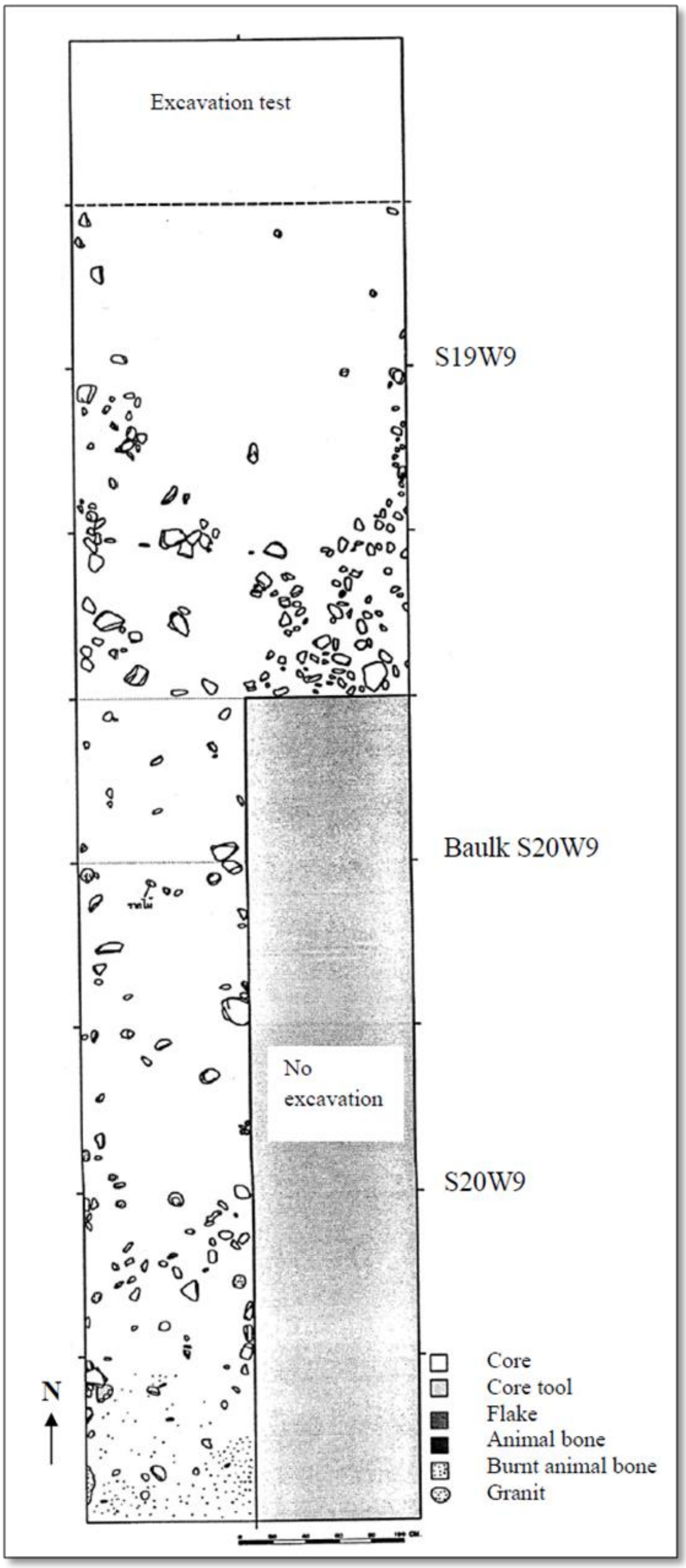


Figure 2.4.23 Plan of excavation, showing the distribution of the archaeological material from the level 13 (660 cm dt.) of area 3 at Tham Lod Rockshelter (Source: Shoocongdej 2003, drawing Krajaejun)

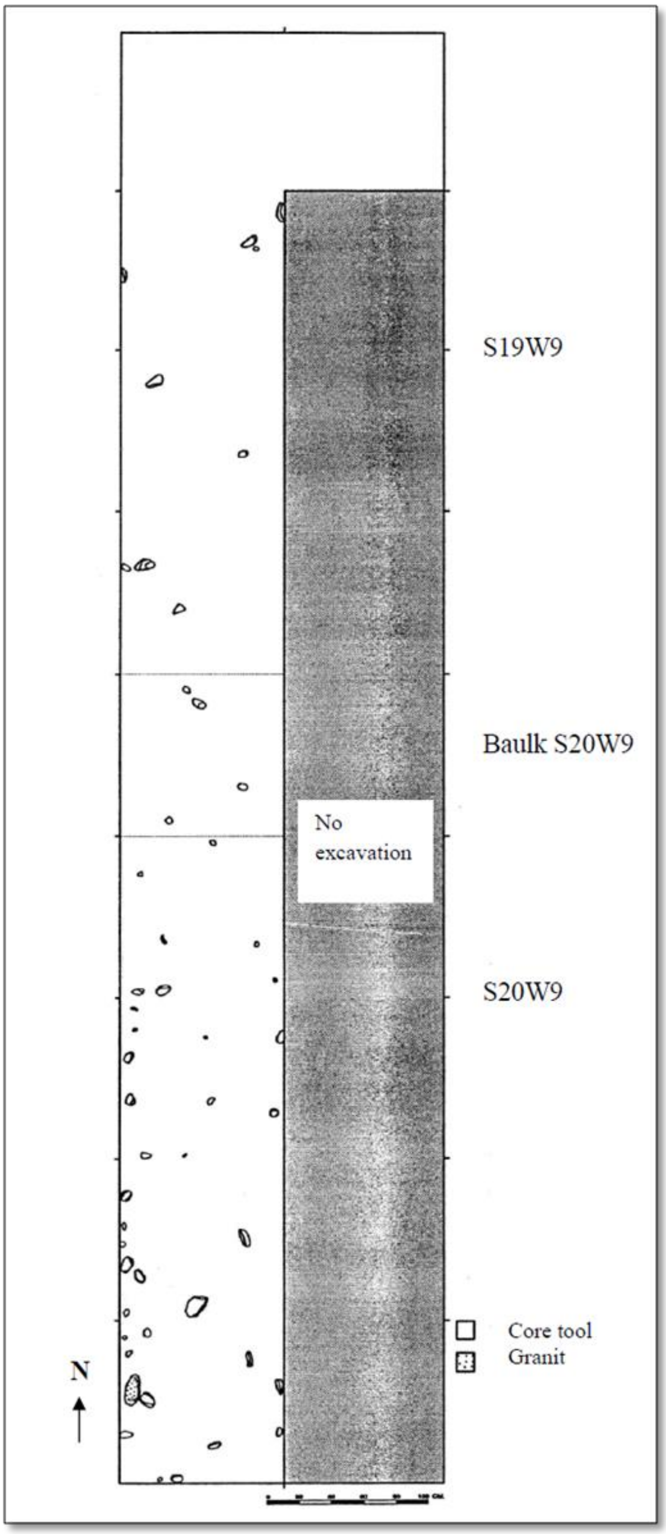


Figure 2.4.24 Plan of excavation, showing the distribution of the archaeological material from the level 18 (760 cm dt.) of area 3 at Tham Lod Rockshelter (Source: Shoocongdej 2003, drawing Krajaejun)

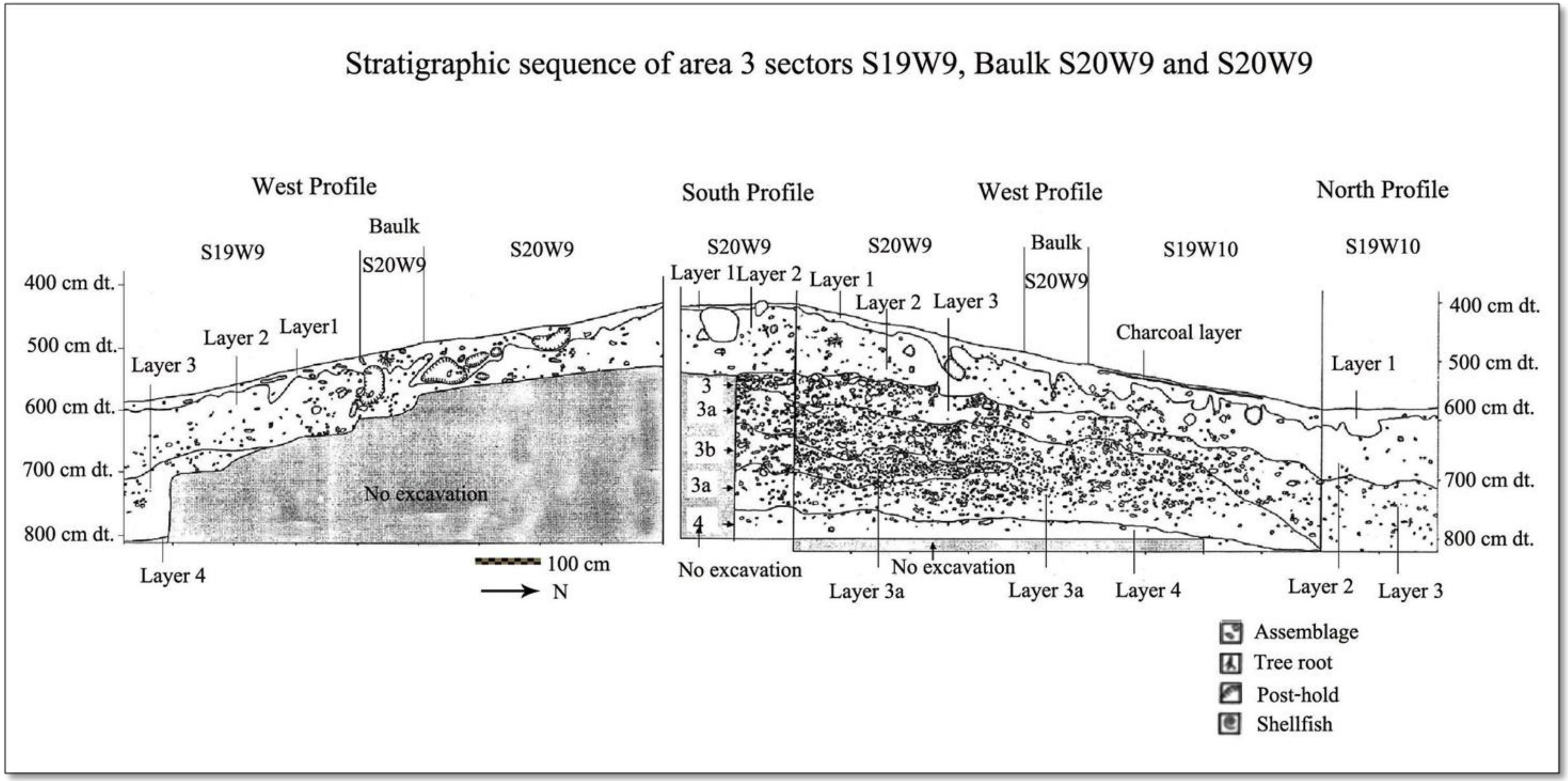


Figure 2.4.25 The four sections of the trench in area 3 showing the stratigraphic sequence of sectors S19W9, Baulk S20W9 and S20W9 at Tham Lod Rockshelter (Source: Shoocongdej 2003)

Figure 2.4.26 Photos of excavation of area 3 at Tham Lod Rockshelter (Source: Khaokhiew 2004)

2.5 Description of the Archaeological materials

The final report of Highland Archaeology of Pang Mapha Project states that the artefacts at Tham Lod Rockshelter belong to different archaeological contexts. These artefacts were a combination of stone artefacts, human skeletal bones, floral and faunal remains including freshwater shellfishes, and potsherds. Some contemporary items such as coins, buttons, cans and glass fragments have also been found on the surface and from the upper levels. The lithic materials and faunal remains were discovered from the numerous assemblages. More than one hundred thousand artefacts were recovered from between late Pleistocene and Holocene period and most of the archeological remains are described below:

1) Lithic assemblages: The stone artefacts from Tham Lod are of various types (large and small) including blank flakes, retouched flakes, shaped cobbles and pebbles, hammerstones, unmodified manuports (cobbles & pebbles), and fragments, along with the gravels and limestone fragments which were scattered widely in and around these layers. Various types of shaped or retouched tools such as the choppers, typical and partial sumatraliths, unifacial discoids, bifacial tools, a few short-axes, scrapers, denticulates, pointed tools and atypical small tools, are well represented. The sandstones are frequently dominant in the raw materials which are easy to find in the locality. A variety of raw materials were used at Tham Lod; gray and black sandstones, quartzite, mudstone, andesite, quartz, siliceous shale and haematite. Especially gray sandstones have been found to compose 90% of the lithic artefacts in the whole sequence. It is to be noted that most of streambeds in this area have deposited clasts, from pebbles (water-worn nodules 2-64 mm) to cobbles (water-worn nodules 64-256 mm), some of which are covered by sandy silts (Marwick 2008: 127). According to Kiernan (1991b), these stream deposits of this region are composed of quartzite and metaquartzite (50%) with smaller proportions of sandstone (20%), mudstone (20%) and other sedimentary and metamorphic lithologies (10%) which were the sources of raw materials for the lithic industries.

The lithic industry of Tham Lod was analysed according to a morpho-technical approach and could be divided into different categories: blank flakes, cores, proper tools (small tool/light -duty tools, length < 10 cm, large tools / heavy-duty tools, length > 10 cm), hammerstones, big fragments (length > 10 cm) and small fragments (length < 10 cm) and unmodified manuports: pebbles (length < 64 mm) & cobbles (length 64 - 256 mm).

2) Faunal remains: Due to the diversity within the habitat, a large variety of animal species were present and a majority of which have been identified in the archaeological record of Highland Archaeology Project of Pang Mapha. Most of animal remains have been classified into different categories like large, medium and small-sized animals, unidentified animals and freshwater shellfish remains. The river (Nam Lang river) can support a wide range of crustaceans, amphibians, reptiles, shellfishes and fishes, as well as mammals and birds that prey on these resources (Amphansri 2004, 2005, 2011; Wattanapituksakul 2006; Krajaejun 2007). According to Higham (2002), the forested areas have been inhabited by a wide range of arboreal and terrestrial species, including the macaque and gibbon. A number of other species such as civets, deer, squirrels, small cats, and wild pigs were existent in the past. Some species of elephants, rhinoceros and tigers were markedly present in this region of North-western Thailand. The mammal remains collected at Tham Lod Rockshelter (**figure 2.5.1**) can be classified in different groups as following:

Large-sized animals: Wild cattle (*Bos javanicus*), wild cattle or buffalo (*Bovidae*), wild pig (*Sus scrofa*), sambar deer (*Cervus unicolor*), common muntjac (*Muntiacus muntjac*), barking deer (*Muntiacus* sp.), dear (*Cervus* sp.), rhinoceros (*Rhinocerotidae*), bears (*Ursidae*), elephants (*Elephans* sp.), tiger (*Felidae*), etc.

Medium-sized animals: Mountain goat, serow (*Naemorhedus / Capricornis sumatraensis*), medium deer (*Cervus* sp.), muntjac (*Muntiacus* sp.), medium wild pig (*Sus scrofa*), bamboo rats (*Rhyzomidae*), porcupine (*Hystricidae*), cat and tiger (*Felidae*), other carnivores (*Carnivora*), gibbon *(Hylobatidae)*, old world monkeys (*Cercophithecidae*), langur (*Colobinae*), etc.

Small-sized animals: Common palm civet (*Paradoxurus hermaphroditus*)**,** Squirrel (Sciuridae), rat (*Rhizomyidae*) and other rodents, bat (Chiroptera), tree shrew (*Tupaia belanger*), Sunda colugo (*Cynocephalus variegatus*), birds, turtles, fishes, etc.

According to Tumpeesuwan (2006: see aslo Shoocongdej 2002, 2003, 2007; Krajaejun 2007), the shell remains were classified in two main groups. A few varieties of gastropods are the first group including snorkel snail (*Rhiostoma* sp.), semi-slug (*Meguastenia* sp.) and a small snail (*Cyclophorus* sp.) which have been found all over the stratigraphic sequence. Most of these gastropods have recently been discovered in limestone forest and can largely be found in North-western Thailand (Wattanapituksakul 2006). The freshwater bivalves are the second group and they belong to two main species: *Margaritanopsis laosensis* and *Brotia baccata*. Both of them were overwhelmingly represented in Tham Lod Rockshelter **(figure 2.5.2)**. It is interesting to note that numerous freshwater shellfish have indicated that they were collected during their maximum growth, probably in the dry season (Khaokhiew 2004; Amphansri 2004, 2005, 2011; Wattanapituksakul 2006; Krajaejun 2007; Marwick 2008; Marwick & Gagan 2011).

Figure 2.5.1 The mammal remains of area 1 of Tham Lod Rockshelter; 1) Three incisors of *Rodentia*, 2) A right lower molar 1 of *Rhizomyidae*, 3) A right upper jaw fragment with molars 1-3 of *Rhizomys* spp., 4) A left lower jaw fragment with molars 1-3 of *Canomys badius*, 5) A right lower jaw fragment with premolar 4 - molar 3 of *Bandicota* sp., 6) A left lower jaw fragment with molars 1-3 of *Bandicota savilei*, 7) A lower jaw fragment with a cheek tooth of *Hystricidae*, 8) A lower jaw fragment with premolar 4 - molar 1 of *Hystricidae* 2 (Source: Wattanapituksakul 2006)

Figure 2.5.2 The freshwater shellfishes from area 3 of Tham Lod Rockshelter (Source: Khaokhiew 2004)

3) Human skeleton remains: The skeleton remains were discovered in association with boulder stones pile in the levels 5 to 6 (190-200 cm dt.) of area 1.

Human skeleton no. 1 was found at a depth of 46 cm from surface. It was complete in its structure, except the skull and mandible which were absent. Several bones from the right part of the body have been found, such as metacarpals, hand phalanges, femur, tibia, metatarsals, one tarsal (left cuboid) and foot phalanges. Both of the pelvic bones were present and quite well preserved, but most of the rest were broken in fragments. A hammerstone was found on top of the femur. The gender or stature has not been identified yet, but the age was assessed as adult (Pureepatpong 2004, 2006; Shoocongdej 2006, 2007).

The human skeletons no. 2, 3 and 4 were discovered from the burial 2 and are described as following:

The skeleton no.2 from the burial 2 was of an adult female of height around 152 cm, aged between 25 and 30 years as assessed from the completely fused epiphyses of long bones, and the complete eruption of upper third molars **(figure 2.5.3)**. It dates to around 13,640 ± 80 B.P (Beta- 168224). This burial was badly disturbed by the intrusions of the overlying layers. (Pureepatpong 2004, 2006; Shoocongdej 2006, 2007).

The skeleton no. 3 was lying in close proximity to the skeleton no. 1 of the same layer, who was an adult. The skeleton remains could be separated by their different sizes and stages of bone development. Even though the skeletons were rather fragmentary, their ages could be assessed from the fragments of long bones. This third skeleton was made up of the fragmentary bones of a child aged between 9 and 13 years old, and was found in a disturbed area of layer 2 (Pureepatpong 2004, 2006; Shoocongdej 2006, 2007).

Skeleton no. 4 was only composed of three bone fragments, along with the head of the left humerus, the distal end of the right fibula, and the scaphoid. The fragments of the humerus and fibula have epiphyses not yet fully fused, indicating that this was an adolescent or young adult aged between 15 and 25 years (Buikstra and Ubelaker 1994; Pureepatpong 1996). The skeleton fragments were in close association with skeleton no. 2 in the layer 3. Despite its young age, the bones were very large and robust. According to Pureepatpong (2004), it was probably of a male.

4) Floral remains: Though palynological studies have been conducted from the whole sequence, but floral remains were only found between layers 3 and 5 of Tham Lod Rockshelter. Some pollen grains of *Pinus* sp., *Calocedrus* sp., Cyperaceae, Fagaceae Poaceae, and spores of Polypodiaceae, Pteridaceae, *Cyathea* sp., *Ophioglossum* sp. were discovered in the area 1, sector S23W10 (Treekanchanawattana and Pumichumnong 2005; Wattanapituksakul 2006). Moreover, the plankton like algae *Concentricystes rubinus* was clearer in the upper levels of layer 3. Most of the pollen remains from late Pleistocene paleoenvironment were indicated to be quite similar to the recent ones. It is to noted that some *Pinus* sp. might reveal the cool temperature during the late Pleistocene (Treekanchanawattana and Pumichumnong 2005; Wattanapituksakul 2006; Pumichumnong 2007).

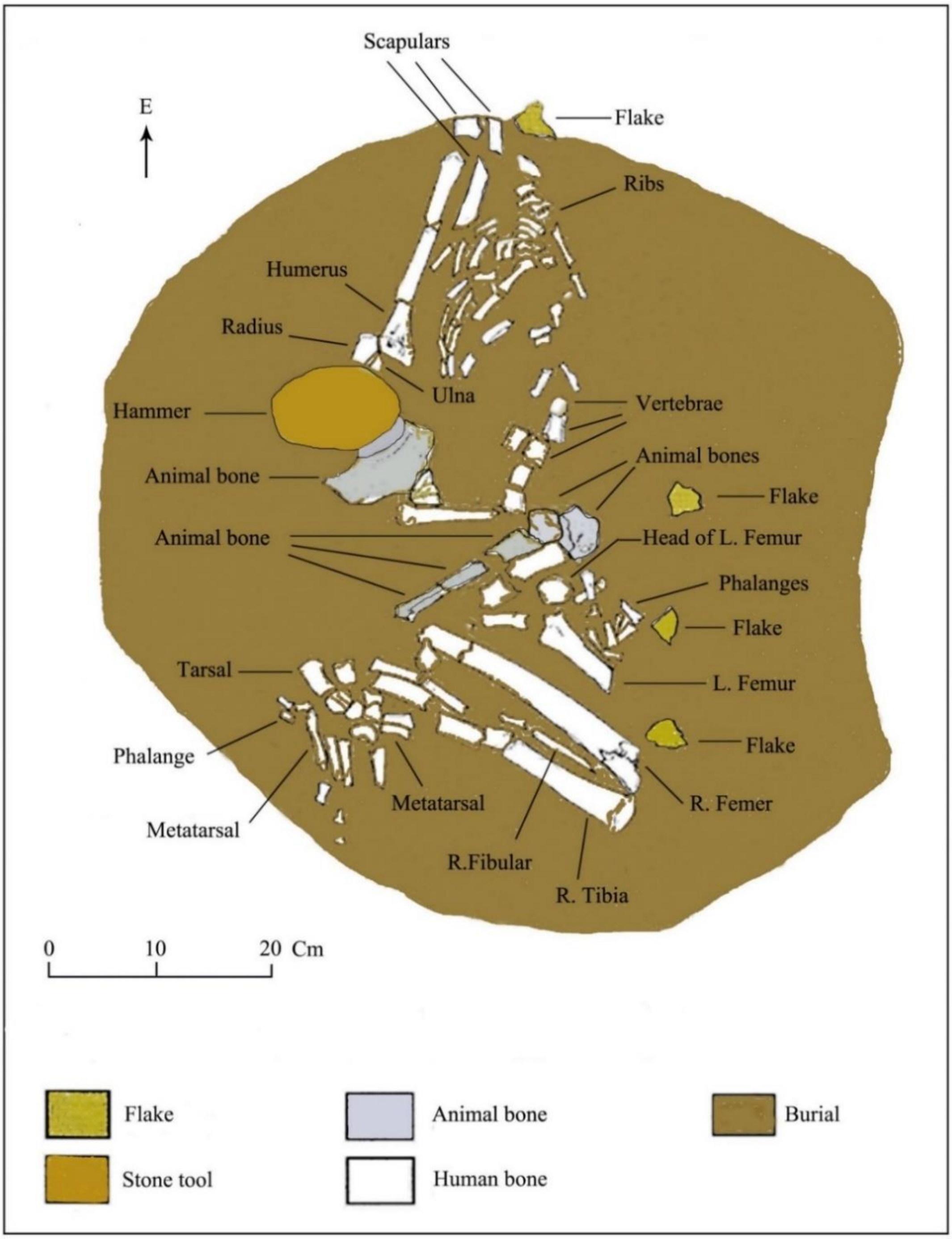


Figure 2.5.3 The human skeleton of burial 2 of area 1 is dated to around 13,690 ± 80 B.P (Sources: Shoocongdej 2003, 2006, 2007; Pureepatpong 2004, 2006)

2.5.1 Archaeological units of Tham Lod Rockshelter, Areas 1, 2 and 3

Partial details of the stratigraphic sequences from Areas 1, 2 and 3 are furnished below. Different sectors of these areas have yielded substantial amounts of artefacts. During the excavation important observations were made on the soil texture, soil colure, approximate pH, organic matter and nature of sediments. Consequently, the unit of the archeological material has received full attention in order to understand the conditions of human occupation, including the domestic activities.

From another perspective, the dating methods were applied to the stratigraphic sequences of several prehistoric sites in Thailand (and Southeast Asia). From the three areas of Tham Lod, the stratigraphic layers have been grouped into different cultural levels, comprehensible to determine the local and regional sequences (Shoocongdej 2002, 2003, 2004, 2005, 2006, 2007; Khaokhiew 2003, 2004). The radiocarbon datings were conducted to identify different occupational episodes. The stratigraphic layers are found to belong to 2 stages of geological time scale: late Pleistocene and Holocene.

The archaeological units of Area 1*:* The sector S23W10 consisted of 8 layers that could be divided into 45 levels. Large quantities of archaeological material such as tools, faunal remains including freshwater shellfishes, floral remains, potsherds and recent items were found; especially the faunal remains were abundant from this sector (Khaokhiew 2003, 2004; Shoocongdej 2003, 2007). All archaeological remains have been collected and recorded. In this area the layers can be grouped into three main units: the upper layers 1 and 2 make up the first unit; the layers 3 to 8 correspond to the middle unit and the lower layer is the base surface (bedrock) with no archaeological remains. The deposits of layer 4 belong to a rock fall, which was completely separated from the middle layers. The oldest date from layer 6 was 32,380 ± 292 B.P. (Akita-TL10).

The archaeological units of Area 2*:* These are comprised of 10 layers, but in the sector S20W10, the stratigraphic layers 5, 6 and 7 were absent: they correspond to a rock fall only occurring in the sector S21W10 and tapering northwards towards S20W10. Significantly, the Pleistocene deposits occurred in layers 3 to 10; the thickness range was approximately 2.0 to 4.5 meters. The oldest date is an AMS date from layer 8 of 26,330 ± 250 B.P. (Beta- 172229, uncalibrated). Archaeological remains were mainly stone artefacts from sectors S20W10 and S21W10. Other archaeological remains: faunal, freshwater shell remains and potsherds have also been recovered.

The archaeological units of Area 3: The sector S20W9 (SEQ 3-4) consisted of 4 layers in the west profile. The archaeological material was deposited rather horizontally compared to that of the other two areas. The oldest date is a TL date from layer 4: 35,782 ± 266 B.P. (Akita-TL1), representing the oldest of Tham Lod Rockshelter (Shoocongdej 2003, 2006, 2007; Khaokhiew 2004). The archaeological material has been classified by Khaokhiew (2003), but he only provided some basic classification and counting of artefact categories. This is perhaps to do with the fact that his work mainly concentrated on geoarchaeology.

From the three areas excavated at Tham Lod Rockshelter, I attempted to combine the archaeological units together by considering the limits between the different layers and the correlations proposed by Khaokhiew 2003, 2004 **(figure 2.4.3)**. The stratigraphic sequence could be divided into 8 layers, but all the layers are not identified in all the three areas; moreover some layers correspond to a rock fall, which only occurs in the sectors closer to the cliff. A total number of eleven Accelerator Mass Spectrometry (AMS) radiometric dates, and the seven thermoluminescence (TL) dates were processed in several layers in the 3 areas (Shoocongdej 2004, 2005, 2006, 2007; Khaokhiew 2004).

Consequently, from the area 1, the stratigraphic layers might correspond to those of the areas 2 and 3, which have been analysed by soil sediments and artefact remains. The lower layers were on the base surface and no archaeological remains have been found in the area 1, but some artefacts were present in the areas 2 and 3. From the middle to upper layers, the assemblages included stone tools and faunal remains and they gradually increased with quite a rich density.

According to excavation report and the available to classification of the archaeological materials, the successive archaeological units, from top to bottom, can be presented as follows:

1) Archaeological Unit 1

Stratigraphic layers (Areas 1, 2 & 3)		**Archaeological materials**
Area 1, S23W10 (Stratigraphic layer 1)	1) Stone artefacts	- Lithic material simply classified as wasted core, utilized core, broken core, hammer, flake, wasted flake and grinding stone. Only 6 wasted cores and 21 wasted flakes were recovered.
	2) Faunal remains	- More than 180 fragments of animal bones were exposed. There were more medium-sized animals than other-sized animals. Around 118 fragments of medium-sized animals, along with burnt bone remains. Other fragments belong to big- or small- sized animals and unidentified animals as well as freshwater shellfishes.
	3) Potshards	- Around 20 potshards were found. Their characteristics are coarse-textured earthenware, which have very dark gray to black colour on both surfaces. Some vessel fragments are plain polished, presenting different types of decoration. A few of them have been polished and smoked.
	4) Recent items	- Some recent items like coins, buttons, can and glass fragments.
Area 2, S20W10 (SEQ 3-4) (Stratigraphic layer 1)	1) Stone artefacts	- The stone artefacts were only described in sector S20W10. A total 114 artefacts were collected. Out of these, there were 16 unmodified manuports, 95 small flake fragments and 3 gravels.
	2) Faunal remains	- Only 7 pieces of medium-sized animals have been found, and most of them were burnt animal bone fragments.
	3) Potshards	- The potshards were quite similar to other sectors. Amount of 101 pieces has been recovered in the top layer, especially the medium and small-sized fragments.

Area 3, S20W9 (SEQ 3-4) (Stratigraphic layer 1)	1) Stone artefacts	- The lithic artefacts have been mentioned in the sector S20W9 (SEQ 3-4), and classified into different categories, like in area 1 sector S23W10. - 3 wasted cores and 31wasted flakes were discovered.
	2) Faunal remains	- Only 16 fragments of animal bone have been collected. There were 10 medium-sized animals, 5 unidentified animals and 1 freshwater shellfish remain, besides some burnt fragments.

Table 2.5.1 Archaeological Unit 1 of Tham Lod Rockshelter (Sources: Shoocongdej 2003, 2007; Khaokhiew 2003, 2004; Amphansri 2004, 2005, 2011; Krajaejun 2007)

Interpretation of Archaeological Unit 1:

The radiocarbon dating is not available for the top layer. The archaeological materials are mentioned above **(Table 2.5.1)**. In this context, the shelter was occupied by prehistoric people, and it could be considered as late Holocene. This context corresponds to the layer 1 of areas 1, 2 and area 3 **(figure 2.4.3)**. Their thickness was of about 15- 45 cm. In this upper layer, some recent items were found in combination with the archaeological remains. Around 20 cm of the top soils and sediments have been disturbed by the villagers (Shoocongdej 2003, 2004, 2005, 2007; Khaokhiew 2003, 2004). Therefore, some evidences such as stone artefacts, faunal remains and potsherds, were found in low degree.

The excavated lithic artefacts include unmodified manuports (cobbles & pebbles), blank flakes and fragments. Most of the raw materials are gray sandstone. The animal bone remains indicate the dominance of medium-sized animals, along with many burnt bone fragments.

Some of these animals are still hunted by the villager in the forest of North-western Thailand like medium deer (*Cervus* sp.), medium wild pig (*Sus scrofa*), tiger (*Felidae*), carnivores (*Carnivora*), old world monkeys (*Cercophithecidae*), langur (*Colobinae*), porcupines (*Hystrix* sp.), serow (*Naemorhedus sumatraensis*) and Bamboo rats (*Rhyzomidae*). It seems that these animals might be present in the concerned period, including the freshwater shellfish remains: *Brotia baccata*, *Margaritanopsis* sp., semi-slug (*Meguastenia* sp.) and mollusca (*Cyclophorus* sp.); some of these are continuously present even to these days (Amphansri 2004, 2005, 2011; Wattanapituksakul 2006; Krajaejun 2007).

The characteristics of potsherds are coarse-textured earthenware of about 800 C^{o} firing. The surface colours are very dark gray to black (10yr 4/1- 4/3). Some vessel fragments are plain polished, with different types of decoration. It is to be noted that many more potsherds were discovered in the second layer (Shoocongdej 2002, 2003, 2004, 2005, 2007).

2) Archaeological Unit 2

Stratigraphic layers (Areas 1, 2 & 3)		**Archaeological materials**
Area 1, S23W10 (Stratigraphic layer 2)	1) Stone artefacts	- A total of 375 stone artefacts were collected. Out of these, there were 125 cores including 30 utilized cores, 56 flakes and 193 wasted flakes.
	2) Faunal remains	- The animal bone remains sharply increased, and around 9200 pieces were discovered. There was a large majority of medium-sized animals, with about 6000 pieces, and then the unidentified animal remains, 2070 pieces, besides some big and small-sized animals. - Around 635 freshwater shells were unearthed: *Brotia baccata*, *Margaritanopsis* sp., *Cyclophorus* sp., and some land snails (*Rhiostoma* sp.).
	3) Potshards	- The number of potshards also increased with a total of 177 fragments. Most of potshards are coarse-textured earthenware, with both inner and outer surfaces of very dark gray to black colour. Some S-Twist and Z-Twist, along with a few cord-marked shards were found.
	4) Ornaments	- Some beads were discovered.
	5) Fire pits	- Many parts of fire pits were scattered in the layer, preferably associated with small granules.
Area 2, S20W10 (SEQ 3-4) (Stratigraphic layer 2)	1) Stone artefacts	- Most of the flakes and fragments gradually increased. There were 47 proper tools, 14 hammers, 83 flake and 577 fragments, but no cores and unmodified manuports (pebbles & cobbles) were exposed.
	2) Faunal remains	- Only 25 medium-sized animals were recorded and no burnt fragment.
	3) Potshards	- Amount of 521 potshards has been inscribed, such as the big, medium and small potshards. The decorations were more S-Twist than Z-Twist. A few vessel fragments were decorated in exterior, besides some cord- marked shards.
Area 3, S20W9 (SEQ 3-4) (Stratigraphic layer 2)	1) Stone artefacts	- 1325 artefacts were discovered. Out of these, there were 176 cores, 16 flakes and 1133 wasted flakes. Cores were composed of 17 utilized cores, 22 broken cores and 137 wasted cores.
	2) Faunal remains	- The 36 animal remains consisted of 10 big-sized animals, 14 medium-sized animals and 12 unidentified animal bones.
	3) Potshards	- The number of potshards was dramatically enlarged. A total 1111 fragments were found, with characteristics quite similar to other areas. - Other potshards were exposed like plain-polished potshards, without decorations, and a few cord-marked or smoked shards.

Table 2.5.2 Archaeological Unit 2 of Tham Lod Rockshelter (Sources: Shoocongdej 2003, 2007; Khaokhiew 2003, 2004; Amphansri 2004, 2005, 2011; Krajaejun 2007)

Interpretation of Archaeological Unit 2:

This unit corresponds to layer 2 in the areas 1, 2 and 3 **(figure 2.4.3)**. The area 1 was not directly dated, but it was estimated to be around 2933 ± 83 B.P. (Akita-TL5) by TL dating, of the organic sediments from area 2, at a depth of 460-470 cm from the base line.

The stone artefacts from area 2 sectors S20W10 and S21W10 were analyzed for this archaeological unit (1107 in the total). Out of these, there were small fragments (848= 77%), blank flakes (147=13%), proper tools (56=5%), hammers (20= 2%), big fragments (27=2%) and unmodified manuports (9=1%). Some actual tools are shown below **(figure 2.5.4)**. The large majority of the raw materials are gray sandstones (more than 90%). The siliceous shales and black sandstones are rare.

In this unit, the lithic artefacts were associated with faunal remains, especially medium-sized animals. The latter seemed to see an increase from this layer. The other-sized animals were moderately present. Around 10 taxa of mammalian diversity from the area 1 were found in this layer: the deer (*Cervus* sp.), wild pig (*Sus scrofa*), tiger (*Felidae*), other carnivores (*Carnivora*), old world monkeys (*Cercophithecidae*), langur (*Colobinae*), porcupines (*Hystrix* sp.), serows (*Naemorhedus sumatraensis*) and Bamboo rats (*Rhyzomidae*). All these mammal species continued to be present in the upper levels and are even found at Pang Mapha district nowadays (Amphansri 2004, 2005; Wattanapituksakul 2006).

It is to be noted that potsherds and ornaments were represented. According to Shoocongdej (2002, 2003, 2004, 2005, 2007), some sediments in this layer have been disturbed by the villagers and several archaeological materials from early Holocene were combined with recent items like in the archeological unit 1 (Khaokhiew 2003, 2004; Shoocongdej 2003, 2007).

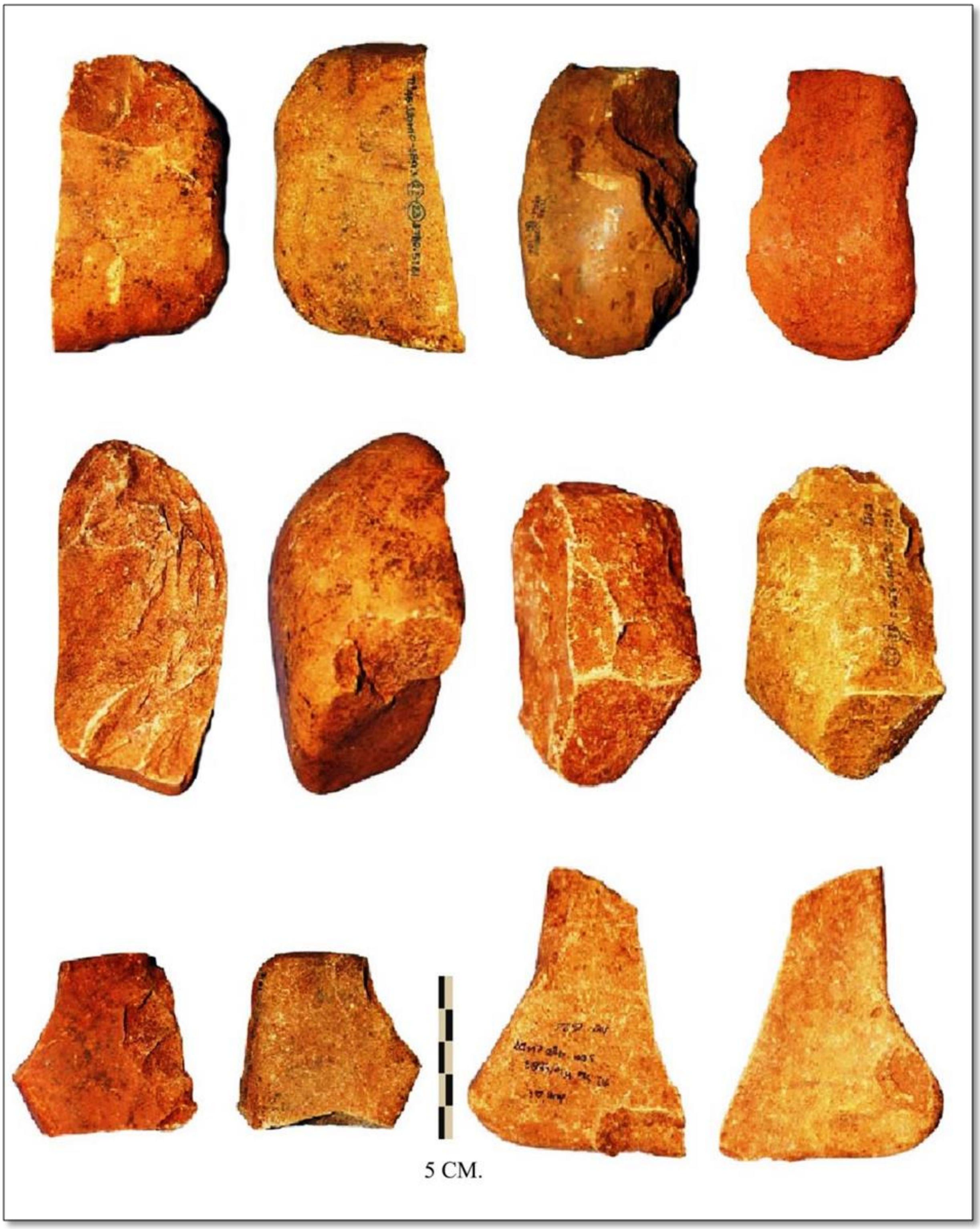


Figure 2.5.4 Stone artefacts from the layer 2 of area 2 sector S20W10 (SEQ 3-4) at Tham Lod Rockshelter

3) Archaeological Unit 3

Stratigraphic layers (Areas 1, 2 & 3)		**Archaeological materials**
Area 1, S23W10 (Stratigraphic layer 3)	1) Burial 1	- ***The human skeleton no.1*****:** Without the skull and mandible, less than 50% of this skeletal remains have survived. Mainly bones from the right side have been recovered. - There were the metacarpals, hand phalages, femur, tibia, metatarsals, one tarsal (left cuboid) and foot phalanges. Both of the pelvic bones were also recovered along with a lot of fragmental remains. The sex or stature of the body couldn't be estimated, but the age was assessed as an adult (Pureepatpong 2004, 2006; Shoocongdej 2006).
	2) Burial 2	- ***The human skeleton no.2*****:** The completeness of this skeleton was approximately 60-70%. Almost all parts of the skeleton were found except the clavicles, sternum and sacrum. - The skull was fragmented and incomplete, with fragments identified as from the frontal, parietal and occipital bones. The upper and lower extremities of the long bones were damaged at the proximal and distal ends except for the left radius. - The shafts of long bones were gracile, but it looked strong with well-developed muscle attachments. No sign of pathology was present. This individual was a female, as assessed from the width of the greater sciatic notch on the pelvic bones and morphology of the skull, e.g. small supraorbital ridges and sharp rims of orbits (Buikstra and Ubelaker 1994; Pureepatpong 2004, 2006; Shoocongdej 2006). - ***The human skeleton no. 3*****:** The completeness of this skeleton was approximately 10-15% because the skull and upper extremities were only found. There were seven fragments of cranium (with unfused cranial sutures), humerus, radius and ulna. - The human skeleton no. 3 was mixed in the same layer with those of human skeleton no.1, who was an adult. Besides, there were two fragments, one of maxilla and one of mandible, with deciduous and permanent teeth still located in the tooth sockets. Assessment of both fragments indicates that they are likely to belong to an individual of nine years in age. The sex and stature of this skeleton could not be estimated (Pureepatpong 2004, 2006; Shoocongdej 2006). - ***The human skeleton no. 4*****:** Only three bone fragments were discovered such as the head of the left humerus, the distal end of the right fibula, and the scaphoid. The fragments of the humerus and fibula did not have fully fused epiphyses, indicating that this was an adolescent or younger adult aged between 15-25 years (Buikstra and Ubelaker 1994; Pureepatpong 1996, 2004, 2006; Shoocongdej 2006).
	3) Stone artefacts	- The number of stone materials sharply increased in this layer. More than 1138 specimens have been collected. Out of these, there were 400 cores including 78 utilized core, 14 hammers, 130 flakes and 603 wasted flakes.

	4) Faunal remains	- A total of 37,255 fragments were found, and approximately 70 % of these were burnt fragments. The medium-sized animals (23,260 items) are more represented than the other-sized animals. - The freshwater shellfish remains frequently appeared: *Margaritanopsis* sp., (1170 specimens) and *Brotia baccata* sp. (41 specimens) have been collected in this layer.
	5) Fire pits	- Traces of fire pits were still present throughout the layer, which were tightly combined with calcretes. Charcoal, ash, stone tools and fired bones were also found scattered around in this layer. They might be associated with fire pits.
Area 2, S20W10 (SEQ 3-4) (Stratigraphic layer 3, in the upper level)	1) Stone artefacts	- The lithic materials were quite a lot and 3154 items have been discovered. Out of these, there were 246 core tools, 338 hammers, 2 cores, 260 flakes, 62 manuports (pebbles & cobbles), 2246 small and big fragments.
	2) Faunal remains	- A total of 209 faunal remains have been recorded and around 60-70% of them were completely burnt. The medium-sized animals were in higher quantities than other-sized animals: 171 medium-sized animals, 32 small sized-animals and 4 unidentified animals were inscribed, besides 2 freshwater shell remains.
Area 2, S20W10 (SEQ 3-4) (Stratigraphic layer 4, in the lower level)	1) Stone artefacts	- A total of 1853 lithic artefacts were collected: 170 core tools, 228 hammers, 32 pebbles & cobbles, 411 flakes and 1012 fragments.
	2) Faunal remains	- The animal bone remains also increased: 2440 fragments were revealed. They consisted of 1992 medium-sized animals, 75 big-sized animals, 19 small-sized animals, 351 unidentified animals and 3 freshwater shellfishes, but around 60-70% of them were burnt fragments.
Area 3, S20W9 (SEQ 3-4) (Stratigraphic layer 3 and upper levels of 3a)	1) Stone artefacts	- A total of 2347 artefacts have been exposed, which is quite more in comparison to the upper layers. There were 563 cores, 29 flakes and 1755 wasted flakes. The number of utilized cores was quite similar to the upper layers; but for the other cores, the broken cores and wasted cores, it slightly increased.
(The artefacts are only present in layer 3)	2) Faunal remains	- The animal bone remains correspond to 231 fragments. Out of these, there were 46 medium-sized animals, 184 unidentified animals and 1 small-sized animal. Most of remains had been burnt.
	3) Potsherds	- Only 21 medium and small-sized potsherds have been recovered. The characteristics are similar to other potsherds from the upper layers, but the colours were more very dark grey to black. Most of potsherds are plain-polished, and without decorated surfaces.

Table 2.5.3 Archaeological Unit 3 of Tham Lod Rockshelter (Sources: Shoocongdej 2003, 2007; Khaokhiew 2003, 2004; Amphansri 2004, 2005, 2011; Pureepatpong 2004, 2006; Krajaejun 2007)

Interpretation of Archaeological Unit 3:

In this unit 3, the stratigraphical sequence corresponded to the layer 3 of area 1, layers 3 and 4 of area 2 and layer 3 of area 3, along with the upper levels of layer 3a **(figure 2.4.3)**. A large part of area 1 is still not excavated, but the layer 3 might be connected with layers 3 and 4 of area 2 followed by the layer 3 and upper levels of layer 3a in area 3. According to Khaokhiew (2003, 2004), the boundary between layers 2 and 3 had a lot of mud sediments, mainly indicating floods of the Paleo-Lang River. This intermediate layer was occupied in the early Holocene. The TL date was processed in the slope of area 3 from organic sediments, providing a date around 10,582 ± 49 B.P. (Akita-TL4) at a depth of 530-540 cm below datum (dt.).

Two AMS dates were processed from area 1, particularly from the upper burial **(figure 2.5.5)**, dated 12,100 ± 60 B.P. (Beta-168223) on the organic sediment of Feature 5 at a depth of 190-196 cm below datum (Pureepatpong 2004, 2006; Shoocongdej 2006). Another result of ^{14}C date was 13,640 ± 80 B.P. (Beta-168224) on the organic sediment of Feature 6, near a hip bone of burial 2, at a depth of 214-234 cm below datum. In addition, in the middle levels of layer 3, the organic sediment has presented a date of 13,422 ± 541 B.P. (Akita-TL7) by TL dating, at the depth of 230-240 cm dt. (Shoocongdej 2004, 2006, 2007; Khaokhiew 2004; Pureepatpong 2004, 2006; Wattanapituksakul 2006). According to Shoocongdej (2006), the result of ^{14}C-AMS dating from area 2 was 15,360 ± 70 B.P. (Beta-206540), on charred bone, at the depth of 490-500 cm dt. from NE quadrant of layer 3. The TL date from area 3 layer 3 was 10,582 ± 49 B.P. (Akita-TL4), on the organic sediment, at the depth of 530-540 cm from datum **(Tables 2.5.8a, 2.5.8b and 2.5.9)**

Burials 1 and 2 showed an interesting aspect; the parts of the human skeletons appearing in this layer noticeably gave details about the ages and genders. Also, some stone artefacts such as flakes and fragments surrounded the burial 1, and three boulder stones were laid in circle above burial 2, along with some faunal remains, flakes and gravels. A hammerstone was placed on the top of the radius and ulna (Pureepatpong 2004, 2006; Shoocongdej 2006).

The quantities of lithic materials increased in this unit 3 compared to the overlying ones, but not much details are available for the classification of artefacts from areas 1 **(figure 2.5.6)** and 3 **(figure 2.5.8)**. From the area 2 sectors S20W10 and S21W10, we identified 5877 lithic artefacts in the archaeological unit 3 (layers 3 to 4) and this is quite more than in other units: flakes (775=13%), cores (3), proper tools (466=8%), hammers (572=10%), big fragments (269=4%), small fragments (3680=63%) and manuports (112=2%). The actual tools **(figures 2.5.7, 2.5.9 and 2.5.10)** consist of choppers (119=26%), scrapers (109=23%), typical sumatraliths (78= 17%) and partial sumatraliths (91= 19%). The other types like denticulates, pointed tools and atypical small tools are very few. The technique of knapping was the free-hand percussion with medium-sized hammerstones, but some shaped tools suggest free-hand percussion with soft hammer in bone or small-sized hammerstones. Large quantities of lithic artefacts and faunal remains were associated with traces of fire pits and were abundantly scattered around them.

Around 20 taxa of the mammalian diversity were gathered from the lower levels of unit 3 in the area 1 (Wattanapituksakul 2006), particularly medium-sized animals. More than 60% of these animal bone fragments were burnt. Therefore, the archaeological evidences such as human skeleton remains are very important to identify the cultural sequences of prehistoric people, especially from these periods (Pureepatpong 2004, 2006).

This unit 3 is capped by a muddy layer deposited by floods of the Lang River Khaokhiew (2003, 2004); it marks the boundary between the late Pleistocene and early Holocene. The date of this deposit, around 10,582 ± 49 B.P. (Akita-TL4), is in connection with the chronology of other sites in Thailand (and Southeast Asia): Spirit cave at 10,390 ± 310 B.P. (TF 803: layer 3), Ban Rai at 10,600 ± 40 B.P. (Beta-16821; layer 4) in North-western Thailand (Gorman 1970, 1971b, 1972; Treerayapiwat 2005), Moh Kheiw at 10530 ± 100 B.P. (OAEP-1115; layer 3) in South-western Thailand (Pookajorn 1984, 1991, 1994, 2001), and Tham Hoi at 10,550 ± 120 B.P. in Vietnam (Bayard 1984; Reynold 1990; Chitkament 2007).

In addition, several prehistoric sites in Southeast Asia were similar in date to these layers just like Tianko Panjang at 10,250 ± 140 B.P. (P-2250), in Sumatra (Snow et al. 1986; Reynolds 1990), Bo Lum at 10,295 ± 200 B.P. (Bln-1001/2) and Sung Sam at 10,770 ± 75 B.P. (Bln- 1541/2) in Vietnam (Bayard 1984; Tan 1980; Pookajorn 1984; Reynolds 1990; Chitkament 2007), layer 11 of Laang Spean at 10,042 ± 43 B.P. (Sophady et al. 2016).

Below this transition layer, the late Pleistocene of Than Lod is similar in chronology to that of Padah-Lin at 13,400 ± 200 B.P. (R-2547/5) in Myanmar (Thaw 1973; Pookajorn 1984), Nui Mot at 14,660 ± 150 B.P. (Bln 1844/2), Soi-Nhu at 15,560 ± 180 B.P (Bln - 1975/2) and Tham Khuang at 15,800± 150 B.P. (according to the new dates) in Vietnam (Bayard 1984; Tan 1980, 1997; Reynolds 1990; Chitkament 2007).

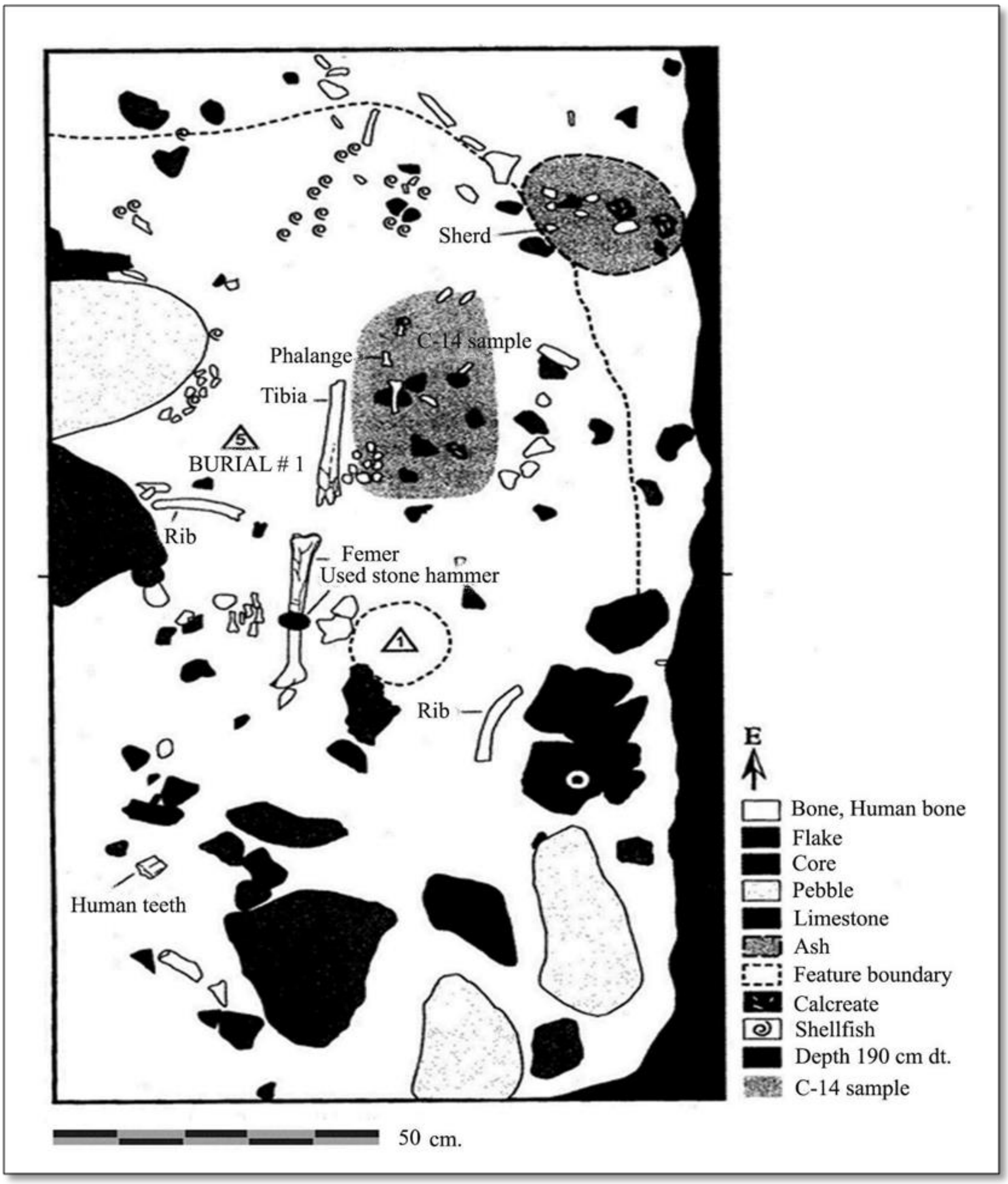


Figure 2.5.5 The human skeleton bones of burial 1 of area 1 dating around 12,100 ± 60 B.P (Source: Shoocongdej 2006)

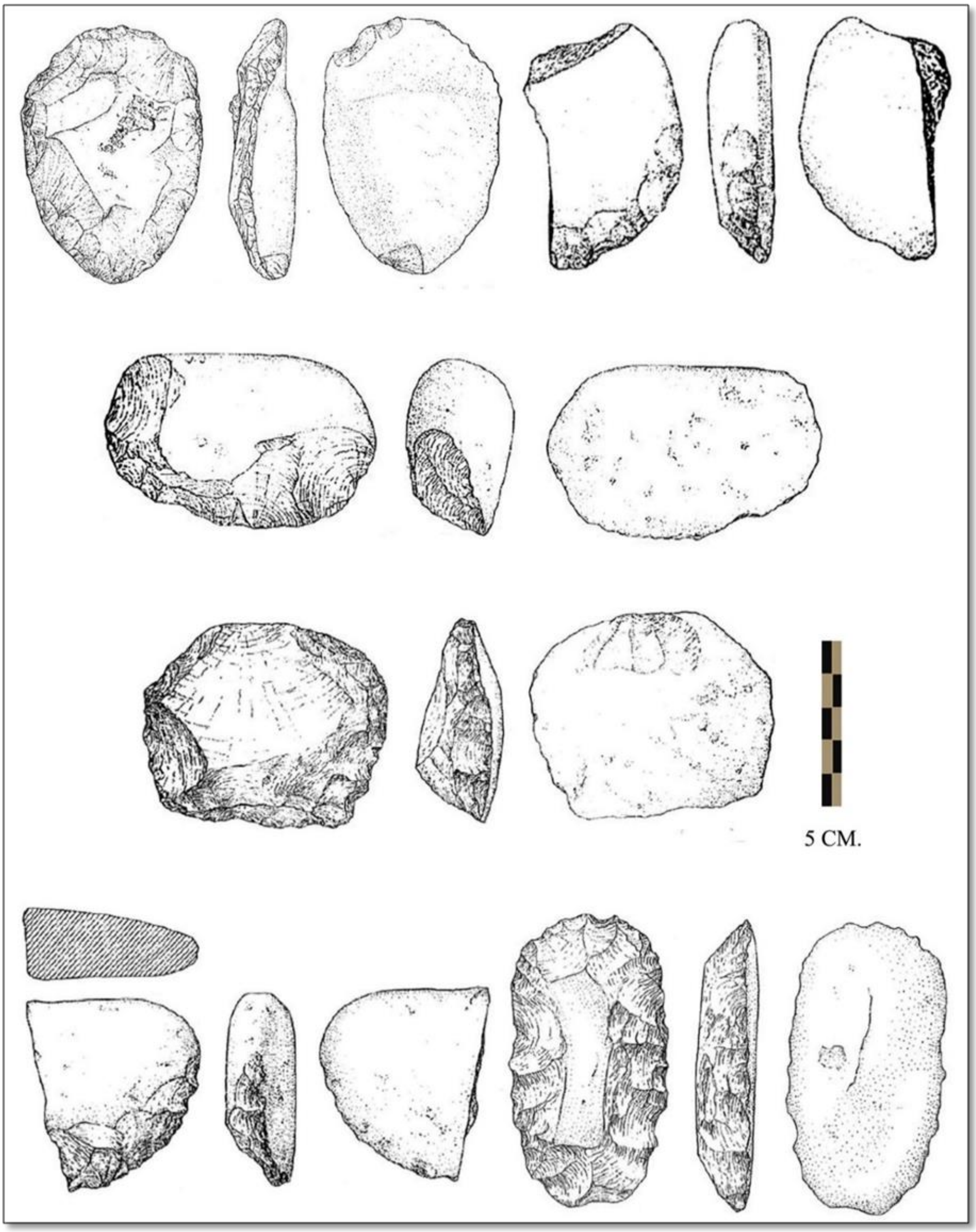


Figure 2.5.6 Stone artefacts from the layer 3 of area 1 sector S23W10 at Tham Lod Rockshelter (Source: Shoocongdej 2003, 2005)

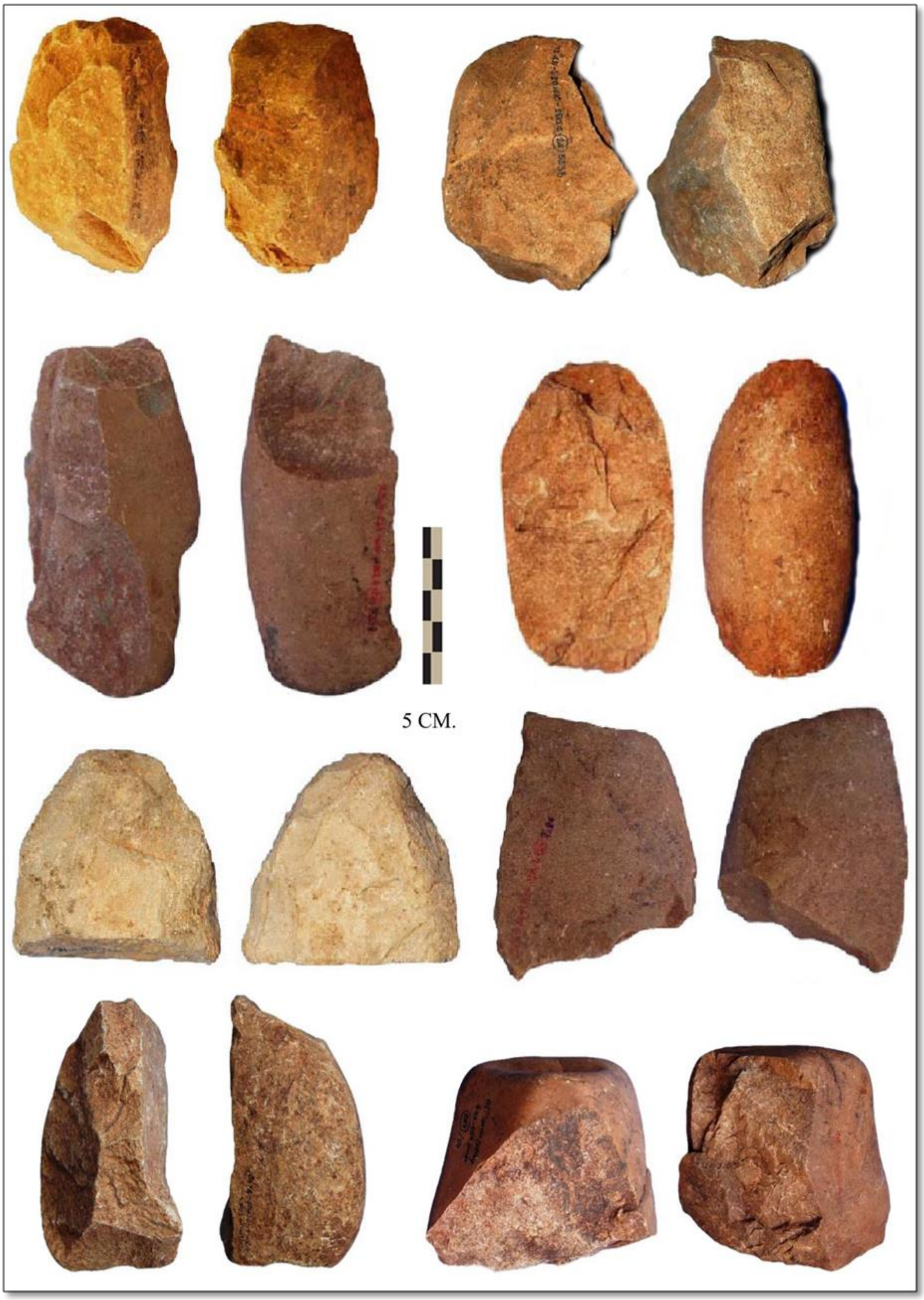


Figure 2.5.7 Stone artefacts from the layer 3 of area 2 sector S20W10 (SEQ 3-4) at Tham Lod Rockshelter

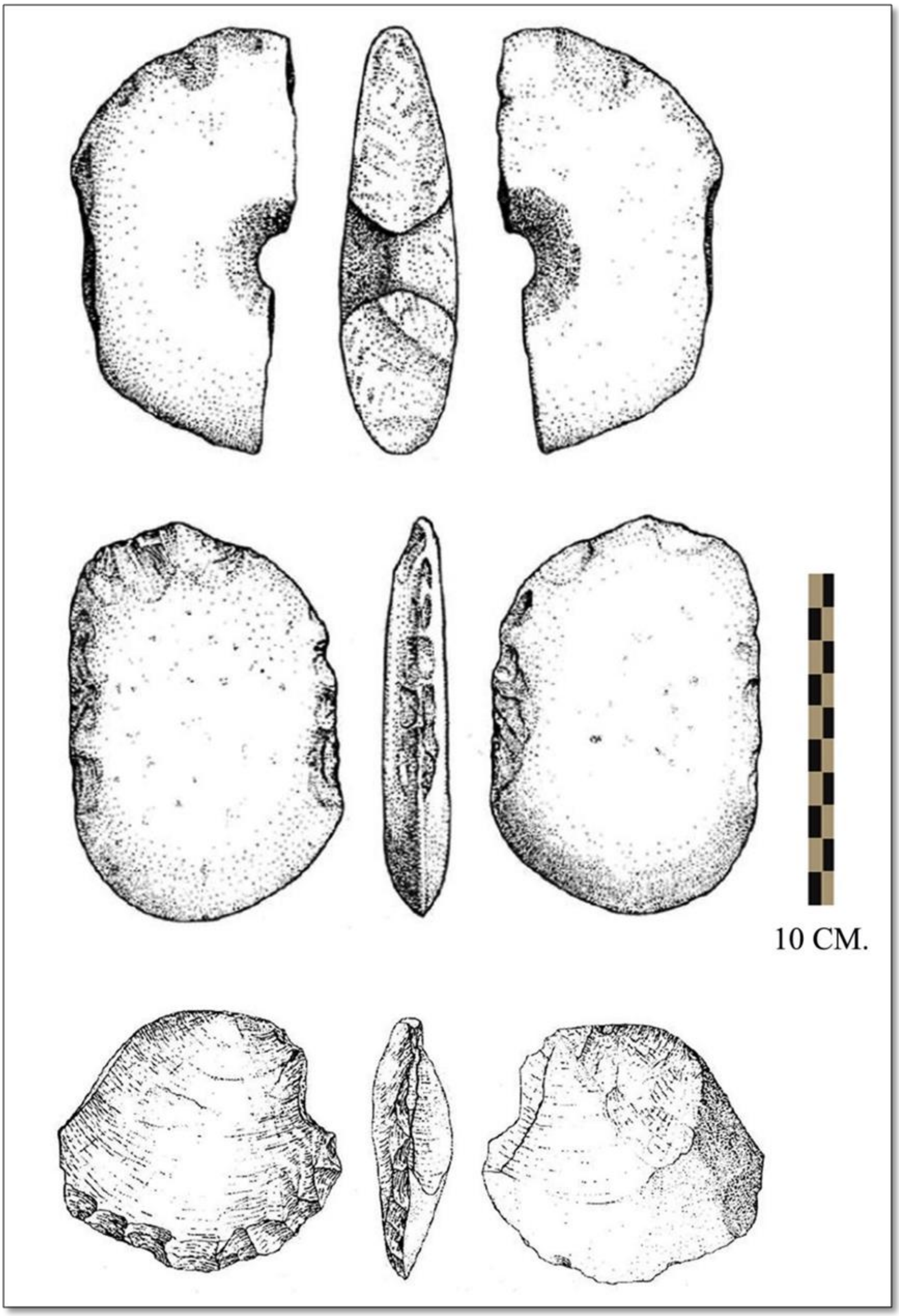


Figure 2.5.8 Stone artefacts from the layer 3 of area 3 at Tham Lod Rockshelter (Source: Shoocongdej, 2003, 2005)

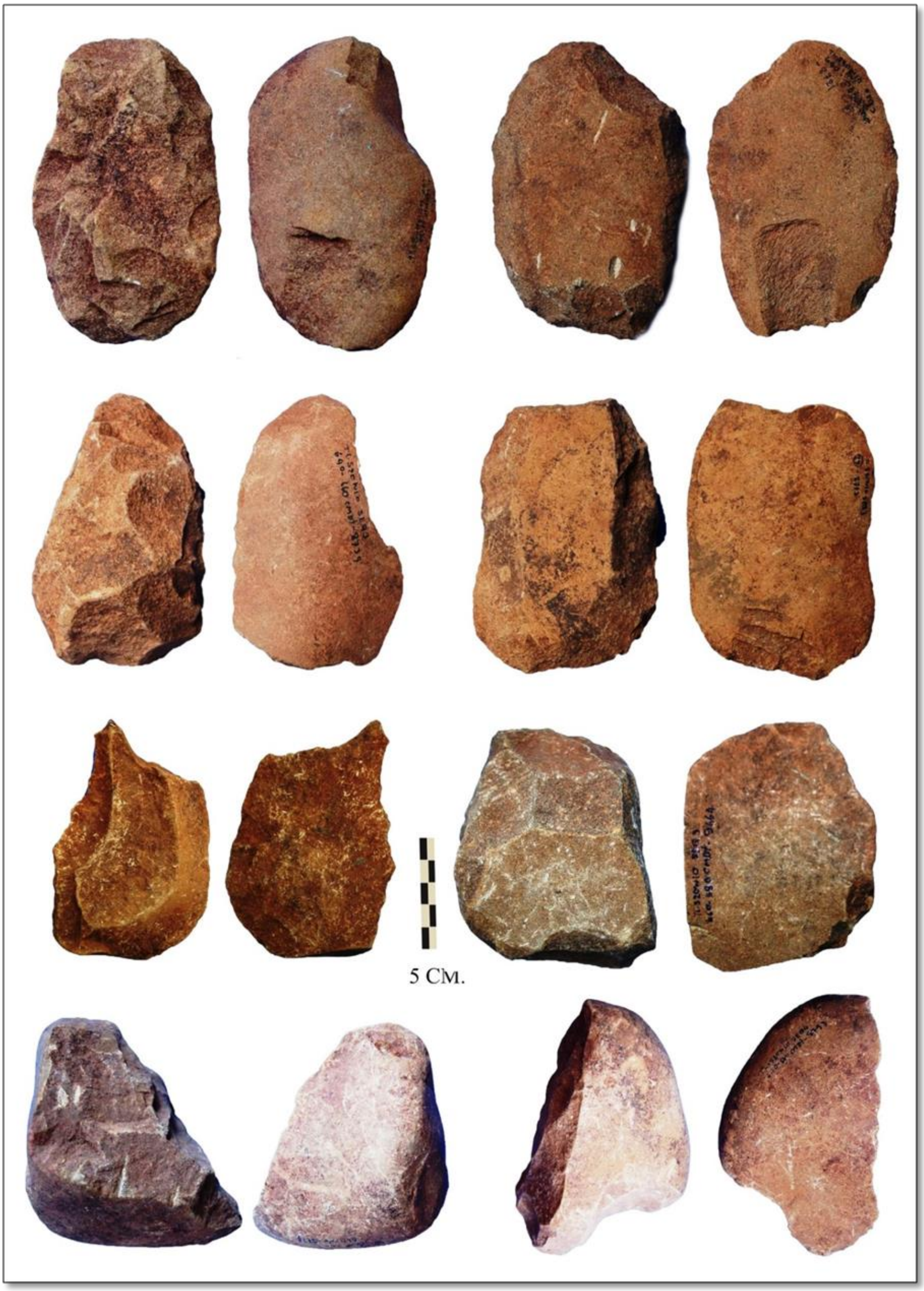


Figure 2.5.9 Stone artefacts from the layer 4 of area 2 sector S20W10 (SEQ 3-4) at Tham Lod Rockshelter

Figure 2.5.10 Stone artefacts from the layer 4 of area 2 sector S20W10 (SEQ 3-4) at Tham Lod Rockshelter

4) Archaeological Unit 4

Stratigraphic layers (Areas 1, 2 & 3)		**Archaeological materials**
Area 1, S23W10 (Stratigraphic layer 4)	1) Stone artefacts	- The stone artefacts were double in comparison with the overlying layer. A total 2660 artefacts have been found. Out of these, there were 412 cores including 90 utilized cores, 45 hammers, 106 flakes, 1970 wasted flakes and 5 grinding stones.
	2) Faunal remains	- More than 70,000 bone pieces were collected, and around 70-80% of them were burnt. The majority corresponds to medium-sized animals with 48,000 fragments besides big, small-sized animals and unidentified animals. - The freshwater shells were quite a few: 2936 pieces of *Margaritanopsis* sp. and 13 pieces of *Brotia baccata*.
Area 2, S21W10 (SEQ 3-4) (Stratigraphic layer 5)	1) Stone artefacts	- The lithic assemblage has been analyzed from sector S21W10 (SEQ 3-4). There were 689 artefacts; 21 tools, 5 hammers, 11 unmodified manuports (pebbles & cobbles), 151 flakes and 501 fragments. -The small fragments were extremely frequent. No big fragments and cores have been found.
	2) Faunal remains	- From the trench SEQ 3-4, a total 4964 bone fragments have been found, and around 60-70% were burnt. Big, medium and small-sized animals, freshwater shells and unidentified animals were discovered. Medium-sized animals were dominant.
	3) Potsherds	- 1081 small-sized fragments of ceramics were recorded. These are coarse textured, with very dark gray to black colours on the surfaces. - A few vessel fragments are of orange and red colours. The types of potsherds are more S-Twist than Z-Twist, and some of these are plain-polished. Other types of potsherds are similar to those from other layers.
(Stratigraphic layer 6)	1) Stone artefacts	- The lithic material decreased. Only 232 artefacts have been recorded: 45 core tools, 2 hammers, 11 unmodified manuports (pebbles & cobbles), 9 flakes and 165 fragments. It is to be noted here that the core tools are proportionally much more than in overlying layers.
	2) Faunal remains	- The animal bone remains also decreased, and around 1711 fragments were collected, mainly from medium-sized animals. More than 70% of them were burnt fragments.
(Stratigraphic layer 7)	1) Stone artefacts	- Amount of 1258 items has been unearthed. Out of these, there were 66 proper tools, 9 hammers, 2 cores, 49 unmodified manuports (pebbles &cobbles), 89 flakes and 1043 small fragments. The actual tools (large & small tools) increased markedly.
	2) Faunal remains	- A total of 3614 specimens has been recorded. All the fragments came from deeper trial pits (SEQ 3), where 60-70 % of burnt animal remains were found. - The animal bone remains gradually increased, and the medium-sized animals were more represented than the other remains.

		- Only 1 piece of freshwater shell was present in the pit, but not identified.

Table 2.5.4 Archaeological Unit 4 of Tham Lod Rockshelter (Sources: Shoocongdej 2003, 2004, 2007; Khaokhiew 2003, 2004; Amphansri 2004, 2005, 2011; Krajaejun 2007)

Interpretation of Archaeological Unit 4:

The stratigraphic sequence of this unit 4 corresponds to a rock fall, and includes the layer 4 of area 1 and the layers 5, 6 and 7 of area 2, sector S21W10 **(figures 2.4.3)**. It does not exist in the northern part of area 2, *i.e.* sector S20W10, and in area 3 which are further away from the cliff.

The result of ^{14}C-AMS dating in layer 4 of area 1 indicates the late Pleistocene time period, with a date of 24,920 ± 200 B.P. (Beta-194122, uncalibrated). This was done on shells associated with burnt animal bones, flakes and cores, at a depth of 310-320 cm from the datum. However, the age of this layer 4 was not considered in this research because it is interpreted as a rock fall (Khaokhiew 2004; Wattanapituksakul 2006).

With a thickness ranging from 20 to 100 cm this deposit is made up of large quantities of calcretes, and limestone granules and boulders; these are found in the layer 4 of area 1, seemingly connected to layers 5, 6 and 7 of area 2 sector S21W10. The rock fall indicates some event of the past and the organic sediment was not dated in this area.

However, in this unit, the layer 4 of area 1 could be estimated to be between 14 and 22 ka B.P. This is because some shell from the underlying layer 5 of area 1 has been dated by AMS method and has yielded a date of 22,190 ± 160 B.P (Beta-172226, uncalibrated). Some quartz from the sediment of the same layer was dated to 22,257 ± 154 B.P. (Akita-TL12). The layer 5 of area 2 would be younger by at least 10 ka B.P. because many potsherds were revealed from this layer (Shoocongdej 2003, 2004, 2005, 2007; Khaokhiew 2004; Wattanapituksakul 2006). As this unit was interrupted by rock fall, it is to be noted that the datings could be considered to erroneous data (Shoocongdej 2003, 2007; Khaokhiew 2003, 2004; Wattanapituksakul 2006). Maybe the layer 5 of area 2 has to be considered as belonging to unit 3, not to unit 4. According to the layer 3 of area 1, the organic sediments were dated between 13, 640 ± 80 B.P. (Beta-168224) and 12,100 ± 60 B.P. (Beta-168223) by AMS method.

The archaeological evidence such as stone tools, bone remains, shells and potsherds were significantly available, especially the animal remains, but they decreased more than in the other units. Around 18 taxa of mammalian fauna were collected from the layer 4 of area 1 (see in the discussion chapter), but the medium-sized animals (more than 65%) were overwhelming by their number in this area. There were more hunter-gather habitations and the numerous fauna remains sharply increased more than 50% from the former archaeological unit (Amphansri 2004, 2005, 2011; Wattanapituksakul 2006).

The densities of lithic industry are comparatively less than in other layers as only 2179 artefacts were collected from the layers 5, 6 and 7 of area 2 sector S21W10 (SEQ 3-4).

This may be due to the large quantity of limestone blocks fallen from the cliff and accumulated in these layers. The sedimentation rate was therefore much higher than in the other layers while the occupation frequency might have been the same or even less as the place had become unsafe due to rock falls. There were 689 items from layer 5, 232 items from layer 6 and 1258 items from layer 7. The main types of lithic artefacts encountered in this layers were small fragments (1709=78%), proper tools (132=6%), blank flakes (249=11%) and unmodified manuports (71=3%). A total of 132 tools (large tools: 59=3% and small tools: 73=3%) was found. Out of these, there were choppers (46/95: 48%), scrapers (33/79=42%), sumatraliths (20/40=50%), partial sumatraliths (22/41=54%) and atypical small tools (7/19=4%).

The large majority of raw materials were obtained from gray sandstone (more than 90% in all the layers), then black sandstone and a few siliceous shales. The technique of knapping was still the free-hand percussion with small and medium sized hammerstones as well as an-anvil and bi-polar techniques, discovered in this unit.

In unit 4, the estimated chronological range allows comparisons with other cultural layers like at Lang Kamnan cave, dated between 15,640 ± 150 (OAEP-1181) and 21,120 ± 460 (OAEP 1195) B.P. in western Thailand (Shoocongdej 1996, 2000).

Other sites from Southeast Asia were also dated to the late Pleistocene: Padah-Lin at 13,400 ± 200 B.P (R-2547/5) in Myanmar (Thaw 1973; Pookajorn 1984; Reynolds 1990), Soi-Nhu at 15,560 ± 180 B.P. (Bln-1975/2), Xom Trai Cave at 17,000 – 18,000 B.P., Nguom at 18,600 ± 200 B.P. (Bln-2692/2), and Phung Quyen at 18,300 ± 125 B.P (Bln-1855/2) in Vietnam (Bayard 1984; Tan 1985, 1997; Reynolds 1990; Chitkament 2007).

5) Archaeological Unit 5

Stratigraphic layers (Areas 1, 2 & 3)		**Archaeological materials**
Area 1, S23W10 (Stratigraphic layer 5)	1) Stone artefacts	- Only three categories of stone artefacts were classified: cores, flakes and pebbles. Out of these, there were 777 cores and 4141 flakes and wasted flakes.
	2) Faunal remains	- The animal remains increased a lot: approximately 148,442 specimens have been collected, especially medium-sized animals (about 100,939 items). Around 70-80% of faunal remains were burnt. - The freshwater shells were often combined with other assemblages: 8529 pieces of *Margaritanopsis* sp. and 52 pieces of *Brotia baccata* sp.
Area 2, S20W10 (SEQ 3-4) (Stratigraphic layer 8)	1) Stone artefacts	- 986 stone artefacts have been analysed. Out of these, there were 60 actual tools, 61 hammers, 20 unmodified manuports, 139 flakes and 706 big and small fragments.
	2) Faunal remains	- A total of 693 specimens has been exposed, most of which are burnt fragments. There were 452 medium-sized animal remains, 25 big-sized animal remains, 4 small-sized animal remains and 212 unidentified bone remains. - No freshwater shells were recorded.
Area 3, S20W9 (Stratigraphic layer 3b)	1) Stone artefacts	- A total of 1054 artefacts were discovered. Out of these, there were 390 cores, 189 flakes and 475 wasted flakes. The cores have been classified into 56 utilized cores, 77 broken cores and 257 wasted cores.
	2) Faunal remains	- The animal remains gradually increased and 638 pieces have been found. Approximately, 70-80% of them were burnt fragments. They include 300 unidentified animals and 273 medium-sized animals, besides 61 big-sized animals and a few small-sized animals. -Only one remain of freshwater turtle was discovered.

Table 2.5.5 Archaeological Unit 5 of Tham Lod Rockshelter (Sources: Shoocongdej 2003, 2004, 2007; Khaokhiew 2003, 2004; Amphansri 2004, 2005, 2011; Krajaejun 2007)

Interpretation of Archaeological Unit 5:

In this unit 5, the stratigraphic sequence corresponds to the layer 5 of area 1, layer 8 of area 2 and layer 3b of area 3 **(figure 2.4.3)**. Their thickness was about 90-100 cm. The limestone fragments mixed up with clayey soil, along with calcretes. The AMS date processed from layer 5 of area 1 was 22,190 ± 160 B.P. (Beta-172227, uncalibrated); it was carried out on a shell at a depth of 420- 430 cm from datum (Khaokhiew 2004; Shoocongdej 2003, 2004, 2006, 2007). Another date was 22,257 ± 154 B.P. (Akita-TL12) by TL method, on a quartz from sediment at the depth of 380-390 cm dt. In area 2, the AMS date processed on charred bones from layer 8 provided a result of 26,580 ± 250 B.P. (Beta-172229, uncalibrated), at a depth of 660-680 cm from the datum (Shoocongdej 2003, 2004, 2005, 2006, 2007; Khaokhiew 2004, Wattanapituksakul 2006; Krajaejun 2007).

According to Shoocongdej (2002, 2003, 2004, 2005, 2007), the archaeological evidences have exceedingly decreased in this unit 5, with the exception of the faunal remains in area 1, where they were found more than in the other layers. A high density of animal bones, especially of medium-sized animals, was discovered: around 148,000 specimens, but more than 60-70% had been burnt. The mammalian diversity increased and was represented by almost 29 taxa in these layers (see in the discussion chapter) (Amphansri 2004, 2005, 2011; Wattanapituksakul 2006).

The amount of 1371 lithic artefacts was discovered from layer 8 of area 2 sectors S20W10 & S21W10. Out of these, there were unretouched flakes (179=13%), small tools (43=3%), large tools (60=5%) and a few other stone artefacts. It was interesting to note that the small fragments represented the large majority (961=70%). The proper tools (large and small tools: **figure 2.5.11**) were comprised of choppers (49=47%), scrapers (23=22%), sumatraliths (11=11 %), and atypical small tools (10=10%). As usually, the raw materials were almost always gray sandstones along with a few pieces of siliceous shales, black sandstones, mudstones, quartzites and andesite.

This unit 5 with its chronology ranging from approximately 22,000 to 27,000 B.P. corresponds to some other sites or cultural layers in Thailand as for example at Lang Kamnan Cave, in western Thailand, where the layer 4 provided dates between 21,120 ± 460 B.P. (OAEP 1195, uncalibrated) and 27,110 ± 500 B.P. (GX-20072, uncalibrated) (Shoocongdej 1996, 2000) and the layer 1 at Moh Khiew dated to 25,800 ± 600 B.P. (TK-933Pr) (Pookajorn 1991, 1994, 2001; Auetrakulvit 1995, 2004) and even to Tham Lang Rongrien Rockshelter at 27,110 ± 615 B.P (SI-6816) (Anderson 1986, 1990; Reynolds 1990).

In Southeast Asia other prehistoric sites were dated to the late Pleistocene: Nguom at 23,000 ± 200 B.P. (Bln-2692/1), in Vietnam (Tan 1985, 1997; Reynolds 1990), top of layer 18 in Laang Spean in Cambodia at 26,000 ± 3,000 B.P. (Sophady et al. 2015) and Tabon at 25,800 ± 600 B.P in the Philippines (Fox 1977).

Figure 2.5.11 Stone artefacts from the layer 8 of area 2 sector S20W10 at Tham Lod Rockshelter

6) Archaeological Unit 6

Stratigraphic layers (Areas 1, 2 & 3)		**Archaeological materials**
Area 1, S23W10 (Stratigraphic layer 6)	1) Stone artefacts	- 72 cores, 701 flakes and wasted flakes have been exposed.
	2) Faunal remains	- The number of animal remains slightly dropped and only 746 pieces have been discovered (Around 70% of burnt fragments). Most of fragments were from medium-sized animals, along with some large and small-sized animals. - Around 296 pieces of freshwater shells were collected.
(Stratigraphic layer 7)	1) Stone artefacts	- Only 2 cores, 124 flakes and wasted flakes were collected.
	2) Faunal remains	- The animal remains sharply decreased as the layer 7 is very thin and only 40 pieces were found. Most of remains were from medium-sized animals; freshwater shells were also present.
Area 2, S20W10 (Stratigraphic layer 9: 720-780 cm dt.)	1) Stone artefacts	- The stone artefacts amount a total of 336 specimens. There were 27 real tools, 40 hammers, 6 manuports (pebbles & cobbles), 84 flakes and 178 small and big fragments.
	2) Faunal remains	- Only 157 animal remains were found and around 80% of them were burnt. These bone fragments represented 4 big-sized and 99 medium-sized animals, along with 52 unidentified remains. - Only 2 pieces of freshwater shells were unearthed.
Area 3, S20W9 (Stratigraphic layer 3a, lower part)	1) Stone artefacts	- A total of 7177 items had been collected, including 1935 cores, 498 flakes and 4744 wasted flakes. Among the cores,184 were utilized, 299 broken and 1452 wasted.
	2) Faunal remains	- The 573 pieces were composed of 372 unidentified animals and 161 medium-sized animals, besides some big and small-sized animals. Many bone fragments were burnt. - Only 1 freshwater shells.

Table 2.5.6 Archaeological Unit 6 of Tham Lod Rockshelter (Sources: Shoocongdej 2003, 2004, 2007; Khaokhiew 2003, 2004; Amphansri 2004, 2005, 2011; Krajaejun 2007)

Interpretation of Archaeological Unit 6:

This unit corresponds to layers 6 and 7 of area 1, layer 9 of area 2 and the lower part of layer 3a of area 3. They were thin layers, approximately 10-30 cm. The result of a TL date from the layer 6 of area 1 was 32,380 ± 292 B.P (AkitaTL10), on calcrete, at depth of 450-460 cm from the base line (Khaokhiew 2004; Shoocongdej 2003, 2004, 2006, 2007).

Next, in the layer 7, with a thickness similar to the layer 6, very few artefacts appeared. No organic sediments have been dated in this layer, but it might be estimated to be around 32-33 ka B.P. There are no dates for the layer 9 of area 2 and lower part of layer 3a of area 3.

The mammalian diversity had decreased, with only found 6 taxa in the layers 6 to 7 of area 1: Rodentia (rodents), Rhizomyiae (Bamboo rats), *Sus scrofa* (Eurasian wild pig), Cevidae (cervids), Bovinae (bovids) and *Naemorhedus* sp. (serow and goral) (Amphansri 2004, 2005, 2011; Wattanapituksakul 2006).

The stone artefacts declined in the layers 9 of area 2 sectors S20W10 and S21W10, but were more revealed in the lower part of layer 3a of area 3 sector S20W9, and gradually decreased in the layer 4. Most of lithic materials were flakes and fragments. A total of 336 artefacts were found from layer 9 of area 2 sectors S20W10 and S21W10. Out of these, there were fragments (486=61%), flakes (147=19%), hammers (41=5%), actual tools (75=10%) and manuports (38=5%). The real tools (75 items: **figure 2.5.12**) were composed of choppers (29=39%), scrapers (19= 25%), sumatraliths (8=11%) and partial sumatraliths (10=13%).

With an assessed age of around 30,000 B.P., the unit 6 of Tham Lod is similar in chronology to other sites in Thailand such as Lang Rongrien Rockshelter at 32,180 ± 1300 B.P (SI-6818), in South-western Thailand (Anderson 1986, 1990) or the base of Obluang at 28,000 B.P. (Santoni et al. 1990). Further in Southeast Asia, Tham Khoung in Vietnam was dated to between 27,000 and 33,150 ± 2300 B.P. (Bln-1418), but a new date gave a result of 15,800 ± 150 B.P.(HCMC-03/93) (Bayard 1984; Reynolds 1990; Tan 1997; Chitkament 2007).

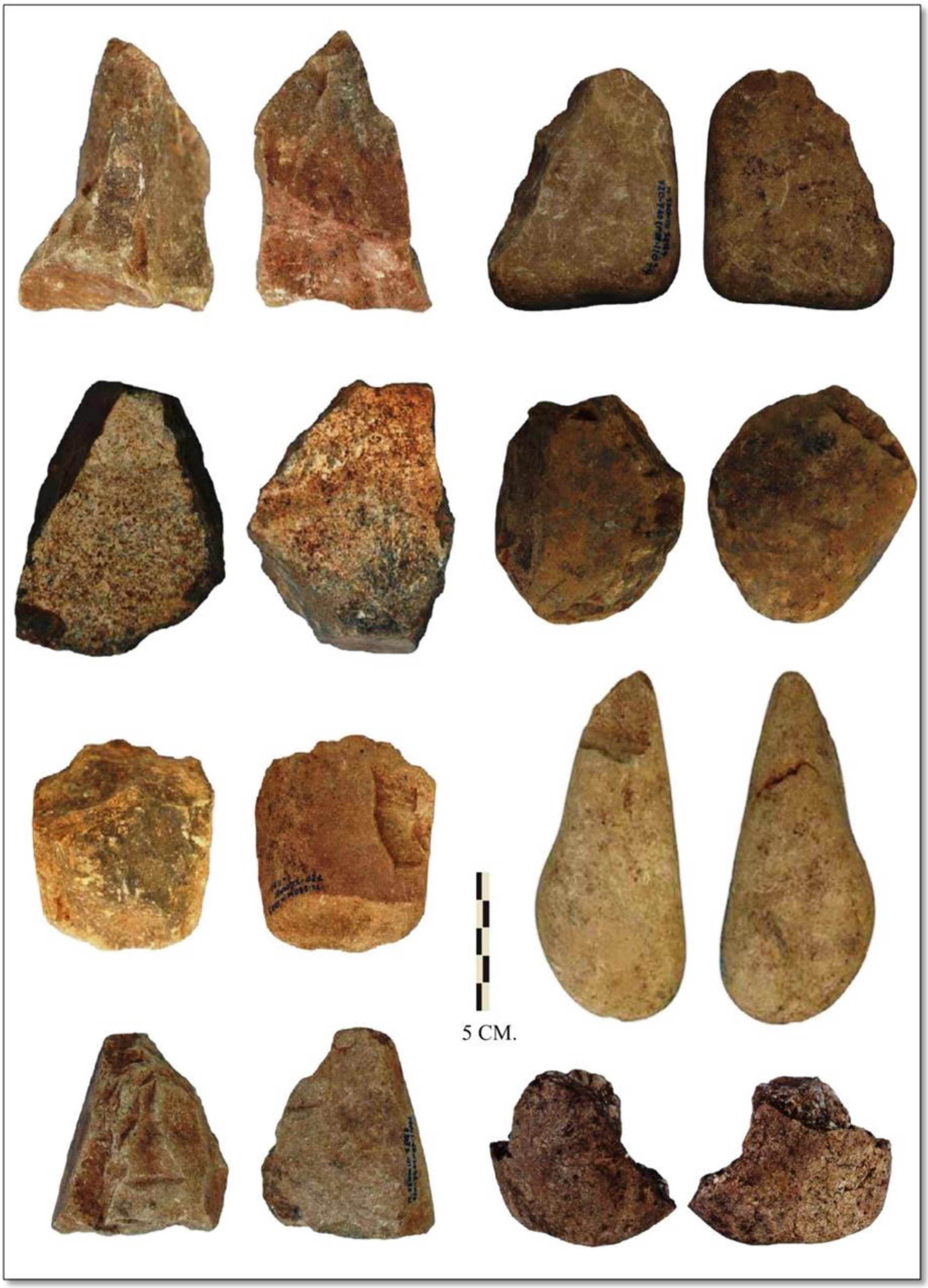


Figure 2.5.12 Several types of core tools from the layer 9 of area 2 sector S20W10 at Tham Lod Rockshelter

7) Archaeological Unit 7

Stratigraphic layers (Areas 1, 2 & 3)		**Archaeological materials**
Area 1, S23W10 (Stratigraphic layer 8a,8)		- No archaeological remains, but the excavated area was very small.
Area 2, S20W10 (Stratigraphic layer 10: 740-780 cm dt.)	1) Stone artefacts	- A total of 516 artefacts has been discovered, including 16 proper tools, 42 hammers, 21 manuports (pebbles & cobbles), 27 flakes and 410 big and small fragments.
	2) Faunal remains	- Approximately 320 fragments of animal bones have been found of which 80% were burnt. These remains were comprised of 177 medium-sized animals, 111 unidentified animals, 31 big-sized animals and 1 small-sized animal.
Area 3, S20W9 **(**Stratigraphic layer 4)	1) Stone artefacts	- The lithic artefacts amount to 647 specimens: 22 flakes, 401 wasted flakes and 224 cores, of which14 were utilized cores, 33 broken cores and 177 wasted cores.
	2) Faunal remains	- The number of animal remains severely dropped, and only 277 pieces were found. Most of these remains were burnt. They represented 117 small-sized animals, 144 medium- sized animals and 46 big-sized animals. - The small-sized animals were proportionally more than in the other layers.

Table 2.5.7 Archaeological Unit 7 of Tham Lod Rockshelter (Sources: Shoocongdej 2003, 2004, 2005, 2007; Khaokhiew 2003, 2004; Amphansri 2004, 2005, 2011; Krajaejun 2007)

Interpretation of Archaeological Unit 7:

In this unit 7, the stratigraphic sequence corresponds to layers 8a and 8 of area 1, layer 10 of area 2 and layer 4 of area 3. Quite significantly, in the lower layer of the area 1, no archaeological remains were found, but the excavated area was very small due to unevenness of the base rock **(figures 2.4.8 and 2.4.9)**. Only gravels and small fragments were combined with clayey soil and more extended in the lower levels.

In area 1, the result of an AMS dating from the layer 8a was 16,750 ± 70 B.P (Beta-172227). This dating was conducted on ash found at a depth of 470-480 cm from the datum. (Khaokhiew 2004; Shoocongdej 2006; Wattanapituksakul 2006). It is surprisingly young as in the underlining boundary of layers 6 and 7 (area 1), the calcrete sediment was dated to 32,380 ± 292 B.P (Akita-TL10) by TL method and this result was consistent with the stratigraphy. The ^{14}C date from this layer 8a was thus considered as an erroneous date, probably resulting from underwater weathering processes. Therefore, the layer 8a might be estimated to date between 33 and 35 ka B.P. Moreover, in area 3, the TL method provided a date of 35,782 ± 266 B.P (Akita-TL1), on quartz from the sediments of the layer 4, at the depth of 750-760 cm from the base line (Khaokhiew 2003, 2004; Shoocongdej 2006; Wattanapituksakul 2006).

Mammalian diversity might be found similar to that of the former archaeological units: Cervidae (cervids), Pecora (ruminants), and *Sus scrofa* (Eurasian wild pig). It is to be noted that these mammals could have adapted themselves to a wide range of available food of plants in several habitats. Essentially, the climate did not change much and some of these mammals could have already adapted themselves to different habitats (Amphansri 2004, 2005, 2011; Wattanapituksakul 2006; Marwick and Gagan 2011).

From the bottom (layer 10) of area 2 sectors S20W10 and S21W10, the stone artefacts amount to 524 items, but most of them were fragments (440=79%), along with hammers (43=8%), unretouched flakes (27=5%) and a few other artefacts. A total of 18 real tools (7= small tools and 11= large tools) were found from this layer and these included choppers (11/18), scrapers (4/18) and a few other tools **(figure 2.5.13)**. No sumatraliths were discovered from this lower layer. The raw materials were mostly gray sandstone besides a few pieces in siliceous shale, black sandstone, quartzite and quartz.

The chronology of this lower unit at Tham Lod may be compared with a few other prehistoric sites in Thailand (and Southeast Asia), dated to around 35 ka like the lower levels of Lang Rongrien Rockshelter at 37000 ± 1780 B.P. (SI-6819; unit 9), in Southwestern Thailand (Anderson 1986, 1990) and Tham Khoung in Vietnam, at 33,150 ± 2300 B.P. (Bln-1418), if the first dating is reliable (Bayard 1984; Reynolds 1990; Tan 1997; Chitkament 2007).

Figure 2.5.13 Several types of core tools from the layer 10 of area 2 sector S20W10 at Tham Lod Rockshelter

Sample No.	Lab No.	Area/ Layer	Material and context	Conventional Age B.P (±1 s.d.)	Calibrated Age Range B.P (±2 s.d.)	Measured Radiocarbon Age	Method	Remark
1	Akita[1]-TL5	Area 2 layer 2	Organic sediment, depth 460-470 cm dt.				TL	2,933 ± 83
2	Beta[2]-206541 MHSTLAR1-731	Area 2 layer 2	Organic sediment from NE quadrant of unit of S10W10, level 23, 520-540 cm dt.	11,550 ± 40	13,830-13440 (B.C 11,880-11,480)	11,630 ± 40	AMS	
3	Beta[2]-168223 MHSTLAR1-402	Area 1 layer 3	Organic sediment from feature 5 near tibia of burial 1, depth 190-196 cm dt.	12,100 ± 60	15,220-14,710 (B.C 13,270-12,760) 14,330-14,020 (B.C 12,380-12070) 13,970-13,830 (B.C 12,020-11,880)	12,100 ± 60	C14	
4	Beta-168224 MHSTLAR1-710	Area 1 layer 3	Organic sediment from feature 6 near hip bone of burial2, depth 214-234 cm dt.	13,640 ± 80	16,820-15,980 (B.C. 14,870-14,030)	13,640 ± 80	13,640 ± 80	
5	Akita-TL7	Area 1 Layer 3	Organic sediment depth 230-240 cm dt.				TL	13,422 ± 541
6	Beta-206540 MHSTLAR2-666	Area 2 Layer 3	Charred bone organic, From NE quadrant of unit S21W10, level 21, depth 490-500 cm dt.	15,360 ± 70	18,810-17,930 (B.C 16,860-15,980)		AMS	
7	Beta-206542 MHSTLAR2-831	Area 2 Layer 3	Organic sediment from NE quadrant 1 of unit of S21W10, level 25, 560-580 cm dt.	21,370 ± 110	Result is outside of the calibration range	21,350 ± 110	AMS	
8	Akita-TL4	Area 3 Layer 3	Organic sediment, depth 530-540 cm dt.				TL	12,100 ± 60
9	Beta-194122 MHSTLAR1-1059	Area 1 Layer 4	Chachoal samples had taken from NEQ3 quadrant corner of level 17, depth 310-320 cm dt.	24,920 ± 200	Result is outside of the calibration range	24,890 ± 200	AMS	Mistaken data, interruption by rock fall

Table 2.5.8a Radiocarbon (AMS) and Thermoluminescence determination from Tham Lod Rockshelter

Sample No.	Lab No.	Area/ Layer	Material and context	Conventional Age B.P. (±1s.d.)	Calibrated Age Range B.P. (±2s.d.)	Measured Radiocarbon Age	Method	Remark
10	Beta-206539 MHSTLAR3-152	Area 3 Layer 3a	Charred material, from SW quadrant of unit S20W9, layer 14, depth 680-700 cm dt.	27,620 ± 170	Result is outside of the calibration range	27,330 ± 170	AMS	
11	Akita-TL6	Area 3 Layer 3b	Organic sediment depth 690-700 cm dt.				TL	14,055 ± 47
12	Beta-206538 MHSTLAR3-141	Area 3 Layer 3b	Charred bone organic, from SW quadrant of unit S20W9, level 11, depth 620-640 cm dt.	19,880 ± 90	Result is outside of the calibration range	19,700 ± 90	AMS	
13	Beta-172226 MHSTLAR1-1526	Area 1 Layer 5	Shell middle from NW, quadrant 4, level 28, depth 420-430 cm dt.	22,190 ± 160	Result is outside of the calibration range	21,860 ± 160	C14	
14	Akita-TL12	Area 1 Layer 5	Sediment Quarts, depth 310-320 cm dt.				TL	22,257 ± 154
15	Akita-TL10	Area 1 Layer 6	Organic sediment depth 450-460 cm dt.				TL	32,380 ± 292
16	Beta-172227 MHSTLAR1-1662	Area 1 Layer 8a	Ashes taken from the middle of NW quadrant1, level 33, depth 470-480 cm dt.	16,750 ± 70	20,430-19,490 (B.C. 18,480-17,540)	16,730 ± 70	AMS	Mistaken data, interruption by ground water
17	Beta-206543 MHSTLAR2-903	Area 2 Layer 8	Organic sediment from, SE quadrant 4 of unit S20W10, level 32, depth 700-720 cm dt.	24,900 ± 160	Result is outside of the calibration range	24,720 ± 160	AMS	

Remark: C14 dates were calibrated using the CALIB 1998 by Stuiver et al. (1998). See more information on Thermoluminescence dates in
Akita1 = Research Institute of Material and Resources, Akita University, Japan
Beta2 = Beta Analytics, Inc.

Table 2.5.8b Radiocarbon (AMS) and Thermoluminescence (TL) determination from Tham Lod Rockshelter (Sources: Shoocongdej 2006, 2007; Wattanapituksakul 2006; Amphansri 2011)

TL Sample*	U (ppm.)	Th (ppm.)	K (%)	%W	Annual dose (mGy/yr)	Paleo dose (Gy)	Age (B.P)
Sample# 1 TL1: Area3 Sediment Quartz from level 750-760 cm dt., Layer 4	3.00	16.41	1.12	3.4	1.29	46.16	35,782 ± 266
Sample# 2 TL4: Area 3 Sediment Quartz from level 530-540 cm dt., Layer 3	6.42414	19.4789	4.7332	2.36	2.37	25.08	10,582 ± 49
Sample # 3 TL5: Area 3 Sediment Calcite from level460-470 cm dt.,Layer 2	11.8241	25.8717	9.9332	2.2	6.014	17.64	2,933 ± 83
Sample # 4 TL6: Area 3 Sediment Quartz from level 690-700 cm dt., Layer 4	3.42414	15.7787	1.7332	5	1.08	15.18	14,055 ± 47
Sample# 5 TL2: Area 1 Sediment Quartz from level 380-390 cm dt., Layer 5	3.065	16.724	1.133	4.8	1.01	22.48	22,257 ± 154
Sample # 6 TL7: Area 1 Calcreate (Calcite) level 230-240 cm dt., Layer 3	2.783	3.9879	1.8648	5.6	0.768	10.32	13,422 ± 541
Sample # 7 TL10: Area 1 Calcreate (Calcite) level 450-460 cm dt., Layer 6	0.837	1.95796	0.5248	4.1	0.378	12.24	32,380 ± 292

Remark: Research Institute of Material Resources, Akita University, Japan

Table 2.5.9 Thermoluminescence dates from west profile at Tham Lod Rockshelter (Sources: Khaokhiew 2004; Shoocongdej 2006, 2007; Wattanapituksakul 2006)

CHAPTER III

Methodology for technical and typological analysis of the lithic assemblages from Tham Lod Rockshelter

During the late Pleistocene and early Holocene, Mainland Southeast Asia was inhabited by prehistoric people making and using particular type of stone tool kit, mainly comprised of simple choppers, chopping tools and handadzes. These artefact assemblages display the simplest technology used by prehistoric people, without definite pattern in core reduction sequences, and are characterised by abundant core-tools, along with some flakes. These assemblages represent the Hoabinhian “culture” or “technical tradition” known to have developed in the late Upper Pleistocene and beginning of Holocene. They have survived in great quantities and can be used as a main source to determine the activities of those prehistoric people. The simple technology they imply is supposed to be balanced by a rich panel of tools made from perishable materials, especially wood and bamboo (see Xhauflair 2014, 2015 and references therein).

3.1 Lithic Technology

Since the introduction by Oskar Montelius (1903), lithic artefacts in Southeast Asia have been mostly studied using the standard typological approach (Nelson 1991, Reynold 1990, 1992), wherein they were largely classified on the basis of their types. The stone artefacts were viewed as finished products, and the past was structured in terms of these “*fossiles directeurs”*. Cultures were described in relation to proportions of different types of artefacts (Rodriguez 2004). This remains true even for the Hoabinhian culture and its regional variants which were markedly reconstructed on the basis of type frequency of stone implements found at sites. This was based on the worldwide trend in lithic studies at that time (Bordes 1950, 1961; Tixier 1956; Kleindienst 1961, 1962; Leakey 1971). In Southeast Asia some lithic assemblages were meticulously studied, by emphasizing on the formal typological approach and classifying tools into different types (Reynolds 1989, 1992; van Heekeren and Knuth 1967; Ha Van Tan 1988; Reynolds 1989, 1990; Anderson 1990; Nishimura 1994).

During the second half of the last century, thanks to the improvement in excavation and sampling methods, lithic assemblages appeared to contain more unmodified artefacts and non-formal tools (Pawlik 2009). Hence, there was a shift towards technology-based analysis of the lithic assemblages investigating the methods of artefact production. This was mainly influenced by the concept of *chaîne opératoire* given by André Leroi-Gourhan (1964) and integration of this approach with the experimental replication of stone artefacts carried out by Bordes (1961), Crabtree (1975) and Tixier (1996).

According to Geneste (1985), *chaîne opératoire* is a holistic approach informing the technological analysis of the sequence of reduction. « *La notion de "chaîne opératoire" est destinée à la compréhension chronologique des divers objets constitutifs d’une industrie. Organiser une chaîne opératoire consiste à définir sur des bases* *expérimentales les étapes chronologiques de la fabrication d'un outillage. Chaque étape théorique pouvant être caractérisée par une ou plusieurs séries de produits, de déchets, de débris, et de produits bruts, destinées à subir d'autres transformations techniques au cours d'étapes ultérieures* » (Geneste 1985).

The *chaîne opératoire* is grounded basically on the reconstruction of the entire life history of an artefact right from selection and procurement of raw material to core reduction sequence and tool manufacture, use, re-use, re-sharpening and discard (Pawlik 2009;Tiauzon 2010: 13). This approach became very popular in lithic studies since the 1980s (Tixier 1978; Tixier et al. 1980; Boëda 1986; Pelegrin et al. 1988; Pigeot 1988; Boëda et al. 1990; Sellet 1993; Roche and Texier 1991, 1995; Texier 1995; Texier and Roche 1992, 1995; Inizan et al.1999; Noll 2000; Bleed 2001; Shott 2003; Soressi and Geneste 2011; Bar-Yosef and Van Peer 2009).

This is also reflected in some contemporary studies in Southeast Asia which conduct detailed investigations of technological aspects of reduction sequence (White and Gorman 1979, 2004; Nishimura 1994; Reynolds 1990, 1992), and also functional aspects via use-wear analysis of core tools (Bannanurag 1988; Nguyen Kim Dung 1994) and flake tools (Jamfoong 1987; Pookajorn 1985, 1988, 1991, 1994, 2001).

Some other studies rather follow an anthropological approach of the technical organisation of lithic assemblages. They try to reconstruct "the dynamics of past behaviours" and the mobility of prehistoric populations within their territory (Shoocongdej 1996, 1996a, 1996b, 2000).

A very complete review of stone artefact studies till date in Thailand has been done by Marwick (2007, 2008, 2008a, 2008b, 2008c).

The lithic assemblages from Tham Lod Rockshelter were presented in the final field work report of Highland Archaeological Project in Pang Mapha (Phase II) by Shoocongdej (2007) yet without details regarding the technology and typology. Technology was elaborately studied under the experimental viewpoint by Marwick (2008, 2008a) who also worked on the human behavioural ecology in North-west Thailand during the terminal Pleistocene and Holocene (Marwick 2008, 2008b, 2008c; Marwick and Gagan 2011). Until now there is no detailed analysis of the technology, morphology and typology of lithic industry from Tham Lod Rockshelter; therefore, it is difficult to compare it with assemblages from other prehistoric sites in Southeast Asia or South and East Asia.

Consequently, this dissertation was conceived to undertake a detailed technological and typological analysis, including the production process and reduction of lithic artefacts from Tham Lod Rockshelter. These artefacts are considered as belonging to Hoabinhian culture with several types of artefacts notified in these stratigraphic sequences. The site has been selected for the present study for the following reasons: it yields well preserved and abundant archaeological material – more than 100,000 artefacts, and most importantly the site reveals a long sequence of cultural deposits – over more than 4 m – with a well-established chronology which can contribute to a better understanding of past human activities (Shoocongdej 1996, 2003, 2004, 2005, 2006, 2007).

3.2 Lithic raw materials

Tham Lod Rockshelter is interesting in that various rock formations occur in the area (see chapter II and **figures 2.3.5 and 2.3.6**). The site is on the border between a limestone karstic area and a clastic formation mainly composed of sandstone and mudstone. In between, the Nam Lang River carries many non-carbonate lithologies, which are usually closely related to hydrological activity.

According to Marwick (2008: 127) the waterways eroded through the limestone to expose non-carbonate and sedimentary rocks and also carried gravels from long distance upstream sources. He suggested two major constraints of the distribution of non-carbonate lithologies for prehistoric people seeking raw materials to make stone artefacts. First, fine-sedimentary raw materials were extremely rare in this landscape where mostly coarser-grained raw materials like quartzite and sandstone were available and have been widely exploited. Second is reduction in the size and quality of the rock as the distance of waterways increases. The cobbles found in the streambed had a small size and their quality was reduced by water flow (Marwick 2008).

There were many natural stones that could be used for making artefacts which were available in this region. Among these various raw materials to make stone implements, prehistoric people preferred the ones they could transport near the campsite. Anyway, the makers chose some homogeneous materials for controlling the flaking process.

The sedimentary rocks used as raw materials were sandstone, mudstone, limestone and siliceous shale. They were the result of alluvial deposits, in Nam Lang River valley and were commonly found in archaeological unit. Around 80-90% of the selected rocks for striking tools in this region during late Pleistocene to early Holocene were sandstones (Khaokhiew 2003, 2004, Shoocongdej 2002, 2003, 2004, 2005, 2006, 2007; Kheawtaya 2005; Marwick 2008).

Overall, the hypotheses about the raw materials at Tham Lod Rockshelter showed that these ones were apparently transported for two main reasons. They could be located away from the area, or closer to the campsite.

Shoocongdej (2003) surveyed the Nam Lang River on a distance of about 10 km from Ban Tham Lod, to study the available raw materials. She did not discover any rests of raw materials such as siliceous shale, andesite, haematite and phtanite. According to geology of Northern Thailand, a series of Triassic sedimentary and metamorphic rocks occur along the southern margin of Mae Hong Son province, near the Mae Sariang district, border between Thailand and Myanmar. The eastern mountains are dominated by Permo-Triassic and Cretaceous -Upper Triassic conglomerate and sandstone sediments (Santisuk 1988). Therefore, prehistoric people could take some raw materials from these areas. The raw materials could be prepared outside of Tham Lod, and then subsequently transported as end-products at the campsite. Otherwise, the raw materials could come from streambeds, waterways following Nam Lang River, where prehistoric people found small size raw materials but still large enough to prepare various types of cobble tools.

3.3 Lithic reduction sequence

In this study the key questions that have been examined with regard to the lithic assemblages concern the procurement, manufacture, use, maintenance and discard of lithic items following Shoocongdej (1996, 2003, 2006, 2007) which illustrates the dynamics of past behaviors and explains the composition of lithic assemblages in terms of variation in past activities and function in cultural systems. The technology, by which tools were produced, could be explained by characterization of the different stages of the production process. At Tham Lod Rockshelter these have the following components:

Flake production: *débitage*		**Large tools: shaping**		**Small tools: shaping or retouching**	
Action	**Product**	**Action**	**Product**	**Action**	**Product**
Procurement →	Initial cobble or pebble				
		(Splitting of cobble →	Split cobble)		
		Shaping of cobble →	Cobble tool / Sumatralith + flake (byproduct)	Shaping of cobble or pebble →	Small cobble tool or small sumatralith, or scraper
Primary reduction (first flake) →	Initial core + first flake				
(Preparation of the core →	Prepared core)				
Core reduction →	Flake / prepared flake + core (byproduct)				
(Core exhaustion →	Exhausted core)				
		Shaping of large flake (>10 cm) →	Large tool on flake + flake (byproduct)	Retouching of ordinary flake (<10 cm) →	Small tool / flake tool (+ micro flake)
Utilization →	Utilized flake	Utilization →	Utilized large tool	Utilization →	Utilized small tool
		Maintenance / resharpening →	Cobble tool / Sumatralith (+ ordinary flake)	Maintenance / resharpening →	Small tool / flake tool (+ micro flake)
Discard →	Utilized flake or blank flake	Discard →	Broken tool / utilized tool	Discard →	Broken tool / utilized tool

Table 3.3.1a The production sequences (*chaînes opératoires*) of stone artefacts at Tham Lod Rockshelter, divided into different stages of artefact's life: flakes, large tools and small tools

Hammerstones	**Manuports (cobble & pebble)**	**Big fragments**	**Small fragments**
Procurement: cobble & pebble	Procurement	Procurement: cobble	Procurement
↓	↓	↓	↓
		breaking	breaking
		↓	↓
Utilization	(Utilization?)	(Utilization?)	(Utilization?)
↓	↓	↓	↓
Discard	Discard	Discard	Discard

Table 3.3.1b The production sequences (*chaînes opératoires*) of stone artefacts at Tham Lod Rockshelter, divided into different stages of artefact's life: hammerstones, manuports, big and small fragments

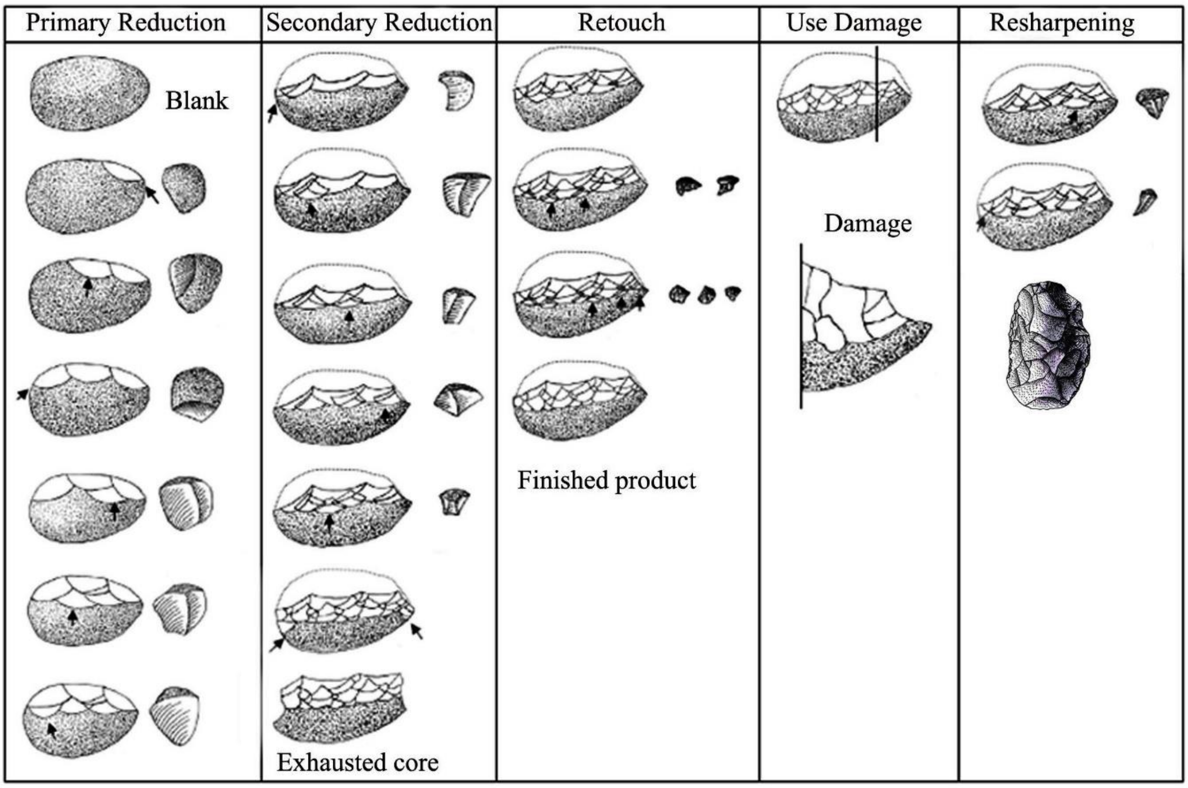


Figure 3.3.1 Schematic of lithic reduction sequence proposed by Ketdhutat 1987 (Modified from Shoocongdej 1996)

Raw material procurement	Raw material procurement is a first step in making and using stone tools. Generally, procurement includes quarrying and / or collection of suitable stone raw materials, which are selected on the basis of their size, rock types and morphological forms of cobbles or blank (Shoocongdej 1996).
	Core blank selection: Prehistoric people chose blanks for core tools. They had to find a good stone, so that the flakes could be easily detached from the core (by using direct percussion technique). Sometimes, at some prehistoric sites, large boulders were split by lighting a fire underneath for cracking the rocks and splitting them. Once, a suitable piece was detached from the boulder, further flakes were removed thereby making a retouched tool, ready to use (Shoocongdej 1996).
	***Transport*:** After selection of the quality and shape of the raw material, this may be transported as such from the location of resource to the site or it may be partly shaped (rough out) or completely shaped (finished tool) before transportation.
Lithic tool manufacturing	Lithic manufacturing processes have the following component in their sequence of production:
	Core reduction: This involves the production of flakes (or blades or any debitage products), from the core, following different methods of debitage. This often also generates significant amounts of debris, usually small pieces that are by products of core reduction. ***Tool blanks:*** These are either cores, debitage products or selected cobbles / pebbles that are intended to be shaped into final tool forms. ***Tool shaping:*** This involves the removal of flakes from the tool blanks in order to obtain the intended shape. For the large tools (e.g., choppers, sumatraliths and bifacial tools), by-products of the shaping will be ordinary flakes and for the smaller tools (e.g. scrapers and denticulates), by-products will be micro-flakes. Shaping modifies the overall shape of the blank; retouch is limited to the edge and doesn't affect much the original shape of the blank.
Tool use	The prehistoric people used stone tools for different activities with different gestures, such as cutting, scraping, digging, picking or hunting.
Tool re-use, maintenance and recycling	Tool maintenance implies resharpening or even reshaping of a tool in order to extend its use life. Ethnographic observations showed that when raw materials were scarce or the camps were far away from resources, the resharpening of tools was more frequent (White and Thomas 1972; Hayden 1977; Shoocongdej 1996: 254).
Discard	The discard is the final stage of the "life" of a stone tool. Shott (1989: 9-30) classifies the discard process into six types: breakage in production, abandonment during or after production, breakage in use, loss or abandonment, depletion and recycling (Shoocongdej 1996).

Table 3.3.2 The reduction sequence of stone artefacts, representing from Tham Lod Rockshelter, North-western Thailand (Source: Shoocongdej 1996)

Lithic production systems

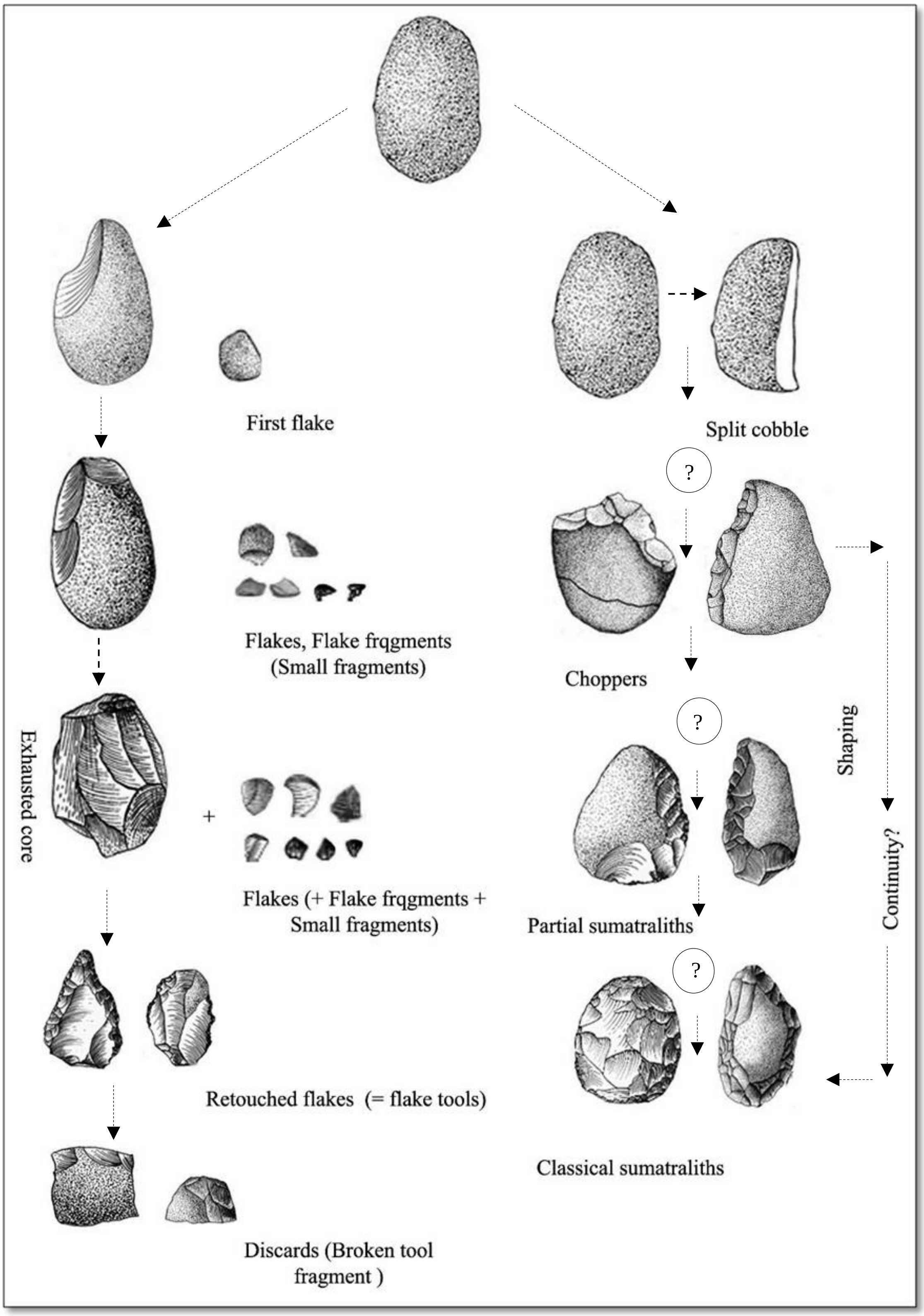


Figure 3.3.2 The lithic production system at Tham Lod Rockshelter, during late Pleistocene to early Holocene, composed of two different processes: core reduction in order to produce flakes (on the left) and shaping of large tools from cobbles (on the right)

To understand the lithic reduction sequence, a series of attributes have been recorded for each artefact recovered from the excavation. These attributes as said earlier are following the Logical Analytical System developed by Carbonell (1985) with some modifications and adaptations, starting with the terminology as a "negative base" will be called "core" and "positive base" will be called "flake". This Logical Analytical System "defines structural categories (and not types) so that each object can be positioned in the production process" (Rodriguez 2004). These structural categories or characters are related to three components: morphotechnical, morphopotential and morphofunctional. In this dissertation only the morphotechnical characteristics are considered. These are technical characteristics generated during production of artefacts which can be seen in the final morphology of the artefact (Carbonell et al. 1992; Carbonell and Rodriguez 1994; Carbonell et al. 1999; Rodriguez 2004).

3.4 Methodology

Since the dissertation aims to understand how the people who occupied Tham Lod Rockshelter were making their implements from the available stone resources (production, maintenance and eventually re-sharpening), what type of tools they ordinarily preferred (small tool on flake or debris, large core-tool on cobble, other), how they were using them, and how these characters changed with time and environment, a detailed analysis of the technology and typology was carried out. The methodology adopted keeps in mind the objectives of the study.

As some of the artefacts are definitely considered as Hoabinhian, the detailed technological study helps in understanding this "techno-cultural" facies. It may be noted here that the validity of the Hoabinhian {defined through the work of French archaeologists working in Vietnam in the 1920s and 1930s (Colani 1927)} as a chronological or cultural concept in Southeast Asia is a subject of ongoing and lengthy debate (Pookajorn 1984, 1988, 1994, 2001, Shoocongdej 1996, 2000, 2006, 2007).

This research also tries to explore the question of variability and standardisation in Hoabinhian assemblages as Hoabinhian lithics are considered to be poorly standardised in comparison to other lithic production systems (Xueping Ji et al. 2015). This study will also help in relating the technological adaptation to the natural conditions, as traditionally Hoabinhian lithics are considered to be an adaptation to seasonal humid tropical hunter-gatherer subsistence. Many archaeologists suggested that this particular Hoabinhian tool kit was specially designed for wood and bamboo working (Testart 1977; Pope et al. 1981; Pope 1989; Hutterer 1985, 1987; Reynolds 1993, 2007; Forestier 2003, 2010).

This work focuses on studying technological organization of a complete Hoabinhian assemblage as against only formal tool types; it shall allow us to understand the diversity and complexity of East Asian assemblages and place them in a global context.

Therefore, this study also aimed to trace technical evolutionary trends and define the relationship between the technical practice used at that time in north-western Thailand and in other parts of Thailand and Southeast Asia. Comparisons with other lithic assemblages from sites located in the tropical environment of neighboring regions, it will put human behaviours in district Pang Mapha in a global perspective.

For this purpose, statistical tools have been utilized to understand characteristic defining features of the lithic assemblage. This has been done as voluminous collections, which are almost impossible to study, could be well understood in the light of percentage of various types, typological characteristics, dimensions and indices. However, it is to be noted that when numbers are small, the percentages are not representative of what may be a larger number: they are not statistically significant. Therefore, in the present work, the percentages are not calculated when the number of specimens is less than 5.

In addition, the use of published and unpublished ethnographical accounts, monographs and field reports in the region – all from the Highland Archaeological Project (2001-2006) have been used document in details the archaeological contexts in which the lithic assemblages were found. Association of the stone tools with such or such assemblage of animal bones, with fire pits, and with any evidence of environmental feature, is highly significant to arrive at a better understanding of the nature of Hoabinhian assemblages. Actually the excavation in Tham Lod Rockshelter was very precisely recorded and reported with great amount of details in the field reports (in Thai); it makes this site a reference for the (emergence and) evolution of the Hoabinhian techno-cultural tradition.

3.4.1) Typological classification

Technological and morphological analyses have not replaced typology. It still remains as the basic instrument for the classification of lithic artefacts. In the same approach as the typology, analysis of technology is possible only if a sufficient number of determined production sequences, separated chronologically and regionally (*Chaînes opératoires*), are available, established and recognized (Pawlik 2009).

In this study, the artefacts have been classified into eight morpho-technical categories such as flakes, cores, small tools, large tools (core tools), hammerstones, big fragments, small fragments and unmodified manuports (pebbles & cobbles):

Flakes	- Flakes are produced by intentionally knapping a block of rock (core or core-tool) rather close to its edge in order to better control the result. - The intentional flakes display characters that allows identifying them: striking platform, point of percussion and a typical conchoidal fracture with a bulb when the flakes are knapped from homogenous rocks. According to the quality of the rock, these characters are more or less easy to recognise. - These characters define the technical orientation of the flakes: the ventral face, with bulb, is the lower face; the striking platform / butt is placed in proximal position, closer to the observer and thus the opposite edge is distal; left and right edges are then fixed (**figure 3.4.3.2**). - Complementary features also help in determining the orientation, especially for broken flakes where the butt and bulb are missing: percussion or pressure ripples, bulb, hackles, etc., visible on the ventral face. - The dorsal or upper face of the flakes corresponds to the former surface of the cores from where they were removed. This surface bears the scars of the earlier flakes removed from the same core or it is cortical in the case of first flakes. - Several groups of flakes may be distinguished according to their maximal dimension: small flakes < 20 mm, ordinary flakes < 100 mm and large flakes > 100 mm. The first ones might not have been produced for utilization, at least in Tham Lod, and they rather result from tool shaping or core preparation if ever. - The flakes of an archaeological assemblage are called “debitage products”

Cores	- Cores are mainly designed for production of flakes. They do not have any preferential and intentionally shaped working edge but they are possibly utilised. - They can be described in terms of striking platforms and debitage surfaces. - Striking platforms receive the energy, trough stroke or pressure, producing the fracture which will detach the flake from the core. - Debitage surfaces are cortical in the beginning of the debitage sequence / core reduction, then they are progressively affected by the flake removals and bear the scars of these removals. - As the fracture develops into the raw material in resonance with masses on both sides (that of the core and that of the future flake), the debitage surface of the core has to be regular and convex. Some particular methods of debitage, like the Levallois method for example, aim at preparing this convexity.
Small tools / Light-duty tools	- Small tools are intentionally retouched flakes, fragments, small cobbles or pebbles with length < 100 mm. - This arbitrary limit of 100 mm has to be discussed according to the distribution of the length of the tools. - The small tool and debris were shaped by free-hand percussion technique, which removed tiny flakes *i.e.* retouches. - Several types of small tools were discovered at Tham Lod, especially some side and end scrapers, which were largely represented.
Large tools / Heavy-duty tools	- Large tools are mainly core tools: tools on cobbles or chunks showing a preferential edge which seems to have been intentionally shaped; their length is > 100 mm. - As for the small tools this arbitrary limit has to be discussed according to the distribution of the length of the tools. It will be shown that for the sumatraliths there is no break in the length distribution at 100 mm but at a lower value. - These tools were shaped by removals of flakes which more or less modify the original shape of the blanks. Flakes resulting from this shaping are usually small flakes or ordinary flakes, not large flakes. - At Tham Lod the technique of shaping seems to be free-hand direct percussion with hard hammer; soft hammer might have been used in rare cases. - Edges of the large tools are sometimes regularised by retouch.
Hammerstones	- Hammerstones are cobbles, pebbles or blocks with battering marks on their surfaces and /or arrises. - They were used to strike lumps of stone during the process of core reduction or tool shaping. - They were rather universal stone tools, and appeared early in most regions of the world.
Big fragments	- Big fragments are pieces of imported rocks > 100 mm. At Tham Lod, most of them were probably flaked or knapped as suggested by their regular, apparently intentional but not typical fractures; besides some were probably thermally broken.
Small fragments	- The small fragments are pieces of imported rock with length measuring < 100 mm. They do no show the typical features of the flakes. - Among them there are probably number of broken flakes which cannot be identified.
Unmodified manuports	- The unmodified manuports were classified into pebbles (water-worn nodules < 64 mm) and cobbles (water-worn nodules between 64 and 256 mm). In some cases, they may be broken and: or utilized.

3.4.2) Sample selection

The site has yielded more than 100,000 artefacts; for this study it was necessary to select a sample. The lithic materials from Tham Lod Rockshelter are stored at Wildlife Education Center, near the rockshelter (approximately 100 m) near Tham Lod Village (Pang Mapha district in Mae Hong Son Province). They are kept in big bags, each bag corresponding to one level in one area The weight of each bag is approximately 30-40 kilograms. All the bags have been sorted into three groups referring to the three areas of excavation **(figure 3.4.2.1 and 3.4.2.2)**.

Figure 3.4.2.1 Preliminary classification of the lithic artefacts from Tham Lod Rockshelter, at the time of excavation (Source: Khaokhiew 2004)

In order to have an idea of the technical evolution throughout the sequence of Tham Lod, it was decided to focus on area 2 as it was located in the center of the site and had a good concentration of lithics. Therefore, the sample was not selected randomly from the whole collection of lithic material from Tham Lod Rockshelter, but it consisted in the materials from two sectors in the centre of the excavation.

The area 2 comprises three sectors of excavation: S21W10 closer to the cliff (south), S20W10 further away (north) and in between the “baulk S21W10” **(figure 2.3.15)**. The study concentrates on the materials from the entire sequence of the first two sectors S20W10 (SEQ 3-4) and S21W10 (SEQ 3-4) in area 2. All the stone artefacts from the upper to the lower layers have been analyzed from these sectors, excluding that from the upper layer 2, which is Holocene.

The lithics from area 2 were taken out from the store and sorted according to the different artefact categories: blank flakes, large tools, small tools, hammerstones, big fragments, small fragments and unmodified manuports (pebbles & cobbles). A total of 160 bags were collected from the sectors S20W10 and S21W10 of area 2. These were classified in ten stratigraphic layers (2 to 10).

Figure 3.4.2.2 Lithic materials from Tham Lod Rockshelter kept at the Tham Lod Natural and Wildlife Education Center, Pang Mapha district, Mae Hong Son province

First, the lithics from sector S20W10 (SEQ 3-4) were analyzed. A total of 7571 items were cleaned and sorted out layer-wise (layers 10 to 8 and 4 to 2, from bottom to top) **(Table 3.4.2.1, figure 3.4.2.3)**. Out of these, there were 1004 flakes, 566 tools (large and small tools), 3 cores, 726 hammers, 141 unmodified manuports (pebbles& cobbles), 346 big fragments and 4785 small fragments.

Figure 3.4.2.3 Preliminary classification of lithic assemblage from area 2, sector S20W10 (SEQ 3-4) of Tham Lod Rockshelter

Later, the stone assemblage from sector S21W10 (SEQ 3-4) was studied, so that the layers 5 to 7, which were considered as a rock fall and were missing in the sector S20W10, be also included in the study. A total of 4276 specimens had been collected from this sector. Out of these, there were 520 blank flakes, 284 all tools (large and small tools), 4 cores, 39 hammers, 144 unmodified manuports (pebbles & cobbles) and 3285 small fragments (**Table 3.4.2.1, figure 3.4.2.4**).

Figure 3.4.2.4 Preliminary classification of lithic assemblage from area 2, sector S21W10 (SEQ 3-4) of Tham Lod Rockshelter

In this dissertation morpho-technical analysis of the lithic assemblage has been made by identification of the technical operational themes following adapted methodology from my Master dissertation entitled *Lithic analysis at Moh Khiew rockshelter "locality I" in Krabi river valley, Krabi province, South-western Thailand*. It is based on the methodologies developed by Carbonell (1985) and applied in the Department of History of Universitat Rovira I Virgili (URV), Tarragona, Spain (*the logical analytical system*) (Rodriguez 2004) and that in the Department of Prehistory of the National Museum of Natural History (MNHN), Paris, France. The system of analysis has been designed keeping in view the local nature of this particular assemblage which is a Hoabinhian assemblage, since it includes typical Hoabinhian tools (named "sumatraliths" or "unifaces"), but may differ from other Hoabinhian assemblages in Southeast Asia and even in Thailand.

Lithic categories **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Flakes**		**Tools (large and small)**		**Cores**		**Hammerstones**		**Manuports (pebbles & cobbles)**		**Big fragments**		**Small fragments**		**Total**	
Layers	**S20W10**	***S21W10***	**S20W10**	***S21W10***	**S20W10**	***S21W10***	**S20W10**	***S21W10***	**S20W10**	***S21W10***	**S20W10**	***S21W10***	**S20W10**	***S21W10***	**S20W10**	***S21W10***
Layer 2	83	*64*	47	*9*	-	-	17	*3*	-	*9*	27	-	550	*298*	724	*383*
Layer 3	260	*85*	246	*20*	2	-	338	*3*	62	*2*	184	-	2064	*345*	3156	*455*
Layer 4	411	*19*	170	*30*	-	*1*	228	*3*	32	*16*	85	-	927	*344*	1853	*413*
Layer 5	-	*151*	-	*21*	-	-	-	*5*	-	*11*	-	-	-	*501*	-	*689*
Layer 6	-	*9*	-	*45*	-	-	-	*2*	-	*11*	-	-	-	*165*	-	*232*
Layer 7	-	*89*	-	*66*	-	*2*	-	*9*	-	*49*	-	-	-	*1043*	-	*1258*
Layer 8	139	*40*	60	*43*	-	-	61	*12*	20	*10*	25	-	681	*280*	986	*385*
Layer 9	84	*63*	27	*48*	1	*1*	40	*1*	6	*32*	11	-	167	*308*	336	*453*
Layer 10	27	-	16	*2*	-	-	42	*1*	21	*4*	14	-	396	*1*	516	*8*
Total	**1004**	***520***	**566**	***284***	**3**	***4***	**726**	***39***	**141**	***144***	**346**	**-**	**4785**	***3285***	**7571**	***4276***

Table 3.4.2.1 Composition of the lithic assemblage from each of the two sectors S20W10 (SEQ 3-4) and S21W10 (SEQ 3-4), area 2, of Tham Lod Rockshelter, in all the stratigraphic layers (2 to 10)

Lithic categories **S20W10 (SEQ 3-4) & S21W10 (SEQ 34)**	**Flakes**		**Small tools**		**Large tools**		**Cores**		**Hammerstones**		**Manuports (pebbles & cobbles)**		**Big fragments**		**Small fragments**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**345**	10	**128**	3	**138**	4	**2**		**341**	9	**64**	2	**184**	5	**2409**	67	**3611**
Layer 4 (340-700 cm dt.)	**430**	19	**121**	5	**79**	4	**1**		**231**	10	**48**	2	**85**	4	**1271**	56	**2266**
Layer 5 (400-470 cm dt.)	**151**	22	**14**	2	**7**	1	**0**		**5**	1	**11**	1	**0**		**501**	73	**689**
Layer 6 (470- 520 cm dt.)	**9**	4	**31**	13	**14**	6	**0**		**2**		**11**	5	**0**		**165**	71	**232**
Layer 7 (520- 580 cm dt.)	**89**	7	**28**	2	**38**	3	**2**		**9**	1	**49**	4	**0**		**1043**	83	**1258**
Layer 8 (58-720 cm dt.)	**179**	13	**43**	3	**60**	5	**0**		**73**	5	**30**	2	**25**	2	**961**	70	**1371**
Layer 9 (620-740 cm dt.)	**147**	19	**39**	5	**36**	5	**2**		**41**	5	**38**	5	**11**	1	**475**	60	**789**
Layer 10 (700-780 cm dt.)	**27**	5	**7**	1	**11**	2	**0**		**43**	8	**25**	5	**14**	3	**397**	76	**524**
Total	**1377**	13	**411**	4	**383**	3	**7**		**745**	7	**276**	3	**319**	3	**7222**	67	**10740**

Table 3.4.2.2 Composition of the lithic assemblage from Tham Lod Rockshelter, area 2, sectors S20W10 (SEQ 3-4) and S21W10 (SEQ 3-4), in the late Pleistocene stratigraphic layers (3 to 10)

3.4.3 Criteria for Flakes Analysis

<table>
<tr><th colspan="12">Dimensions</th></tr>
<tr><td colspan="4">- Length (in mm)</td><td colspan="4">- Width (in mm)</td><td colspan="4">- Thickness (in mm)</td></tr>
<tr><th colspan="12">Ventral face</th></tr>
<tr><td colspan="6">Type of Bulb</td><td colspan="6">Delineation</td></tr>
<tr><td colspan="6">- Marked
- Diffuse</td><td colspan="6">- Straight
- Convex
- Concave
- Sinuous</td></tr>
<tr><th colspan="12">Butt or striking platform</th></tr>
<tr><td colspan="4">Corticality of butt</td><td colspan="4">Type of butt (including facets)</td><td colspan="4">Angle of butt</td></tr>
<tr><td colspan="4">- Totally cortical
- Cortical dominant (>50% cortical)
- Non-cortical dominant (<50% cortical)
- Non cortical</td><td colspan="4">- Plane
- Linear
- Punctiform
- Bifacetted
- Multifacetted</td><td colspan="4">- Very-acute (<30°)
- Acute (30°-60°)
- Oblique (60°-80°)
- Steep (80°-100°)
- Steep-inverse (>100°)</td></tr>
<tr><th colspan="12">Dorsal face</th></tr>
<tr><td colspan="3">Amount of cortex</td><td colspan="3">Direction of scars</td><td colspan="3">Number of scars</td><td colspan="3">Number of arrises</td></tr>
<tr><td colspan="3">- Totally cortical
- Cortical dominant
(>50% cortical)
- Non-cortical dominant
(<50% cortical)
- Non cortical</td><td colspan="3">- Unipolar
- Bipolar-opposite
- Bidirectional-orthogonal
- Three-directions
- Convergent
- Undetermined
- Absent</td><td colspan="3">- 1 scar
- 2 scars
- 3 scars
- 4 scars
- 5 scars
- 6 scars
- 7 scars
- 8 scars
- > 9 scars</td><td colspan="3">- 1 arrise
- 2 arrises
- 3 arrises
- 4 arrises
- 5 arrises
- 6 arrises
- 7 arrises
- 8 arrises
- > 9 arrises</td></tr>
<tr><th colspan="12">General Morphology</th></tr>
<tr><td colspan="4">Frontal morphology</td><td colspan="4">Sagittal morphology</td><td colspan="4">Transversal morphology</td></tr>
<tr><td colspan="4">- Almond
- Quadrangular
- Circular
- D-shape
- Irregular
- Oval
- Pentagonal
- Right triangular
- Triangular
- Trapezoidal</td><td colspan="4">- Almond
- Quadrangular
- Circular
- D-shape
- Irregular
- Oval
- Pentagonal
- Right triangular
- Triangular
- Trapezoidal</td><td colspan="4">- Almond
- Quadrangular
- Circular
- D-shape
- Irregular
- Oval
- Pentagonal
- Right triangular
- Triangular
- Trapezoidal</td></tr>
<tr><th colspan="12">Angle of edges (for each: right, left, distal, proximal)</th></tr>
<tr><td colspan="2">- Very-Acute: <30º</td><td colspan="2">- Acute: 30º-60º</td><td colspan="3">- Oblique: 60º-80º</td><td colspan="2">- Steep: 80º-100º</td><td colspan="3">- Steep-inverse: >100º</td></tr>
<tr><th colspan="12">Damage of the edges (for each: right, left, distal, proximal)</th></tr>
<tr><td colspan="6">- chipping</td><td colspan="6">- pounding</td></tr>
</table>

Table 3.4.3.1 Criteria for the analysis of flakes or "positive bases" (Source: Xosé Pedro Rodriguez 2004)

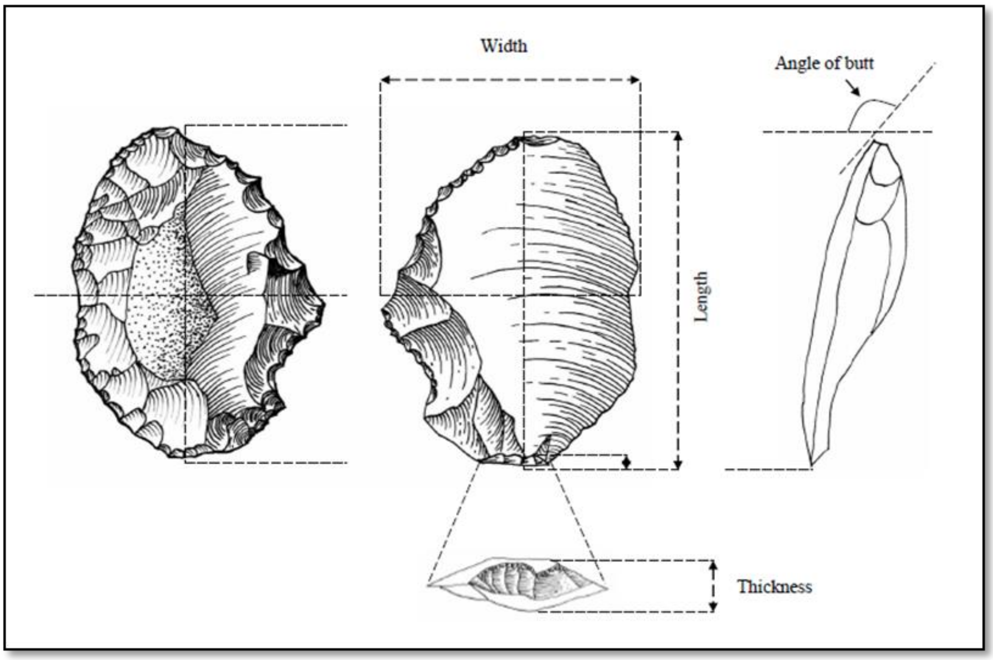


Figure 3.4.3.1 Distribution of the dimensions of flakes, showing the length, width and thickness

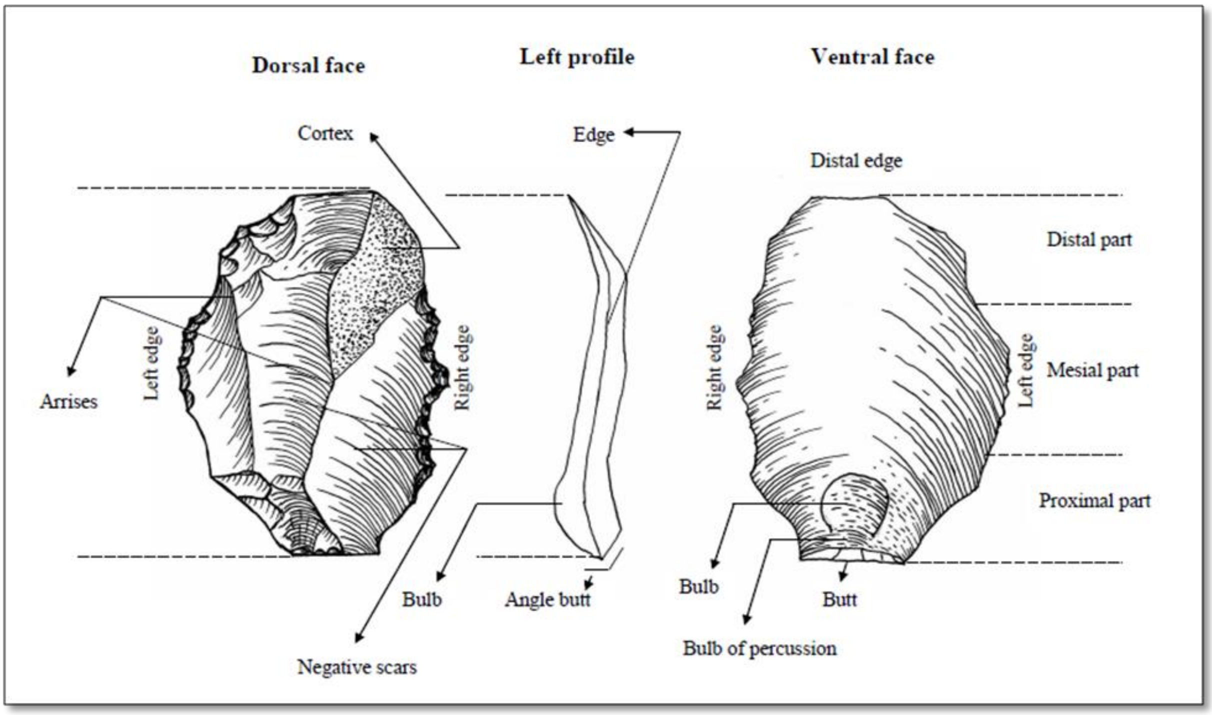


Figure 3.4.3.2 Main descriptive terms for flakes, represented on the ventral and dorsal faces

***1) Dimensions of fakes**:* Measurement

All the flakes were technically oriented with the striking platform in proximal position (at the bottom), and the ventral face (with bulb) in lower position **(figure 3.4.3.1)**. The length, width and thickness were measured with a Vernier Calliper.

***Maximum length*:** The length is the maximal dimension measured from the proximal end of the flake (butt) to its distal end, parallel to the technical axis (direction of percussion).

Maximum width: The width is the maximum dimension perpendicular to the length.

Maximum thickness: The thickness is likewise measured perpendicularly to the grand plane of the flake.

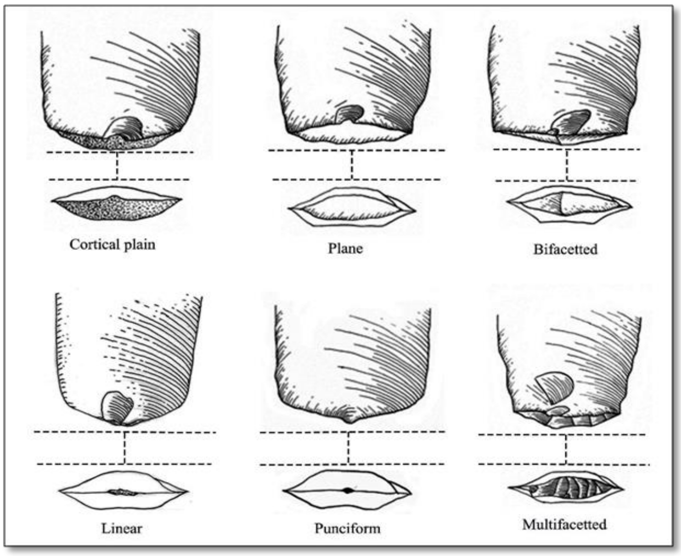
2) Ventral face

Type of bulb	***Delineation***
- Marked - Diffuse - Absent - Undetermined	- Straight - Convex - Concave - Sinuous

Characters of the bulb may help in precising the technique, *i.e.* whether the knapping was performed by using hard hammer or soft hammer like antler, bone, etc.

3) Butt or striking platform

Corticality of butt	***Type of butt (including facets)***	***Angle of butt***
- Totally cortical - Cortical dominant *(>50% cortical)* - Non-cortical dominant *(<50% cortical)* - Non cortical	- Plane - Linear - Punctiform - Bifacetted (dihedral) - Multifacetted	- Very-acute *(<30°)* - Acute *(30°-60°)* - Oblique *(60°-80°)* - Steep *(80°-100°)* - Steep-inverse *(>100°)*



Characters of the butt provide some indication about the striking platform of the core, whether it was cortical and therefore at the beginning of the reduction sequence, or plane without cortex further ahead in the sequence. Striking the core on a ridge or on a corner will produce a flake with linear or punctiform butt. Facetted butts witness a careful preparation of the flake production (**figure 3.4.3.3**).

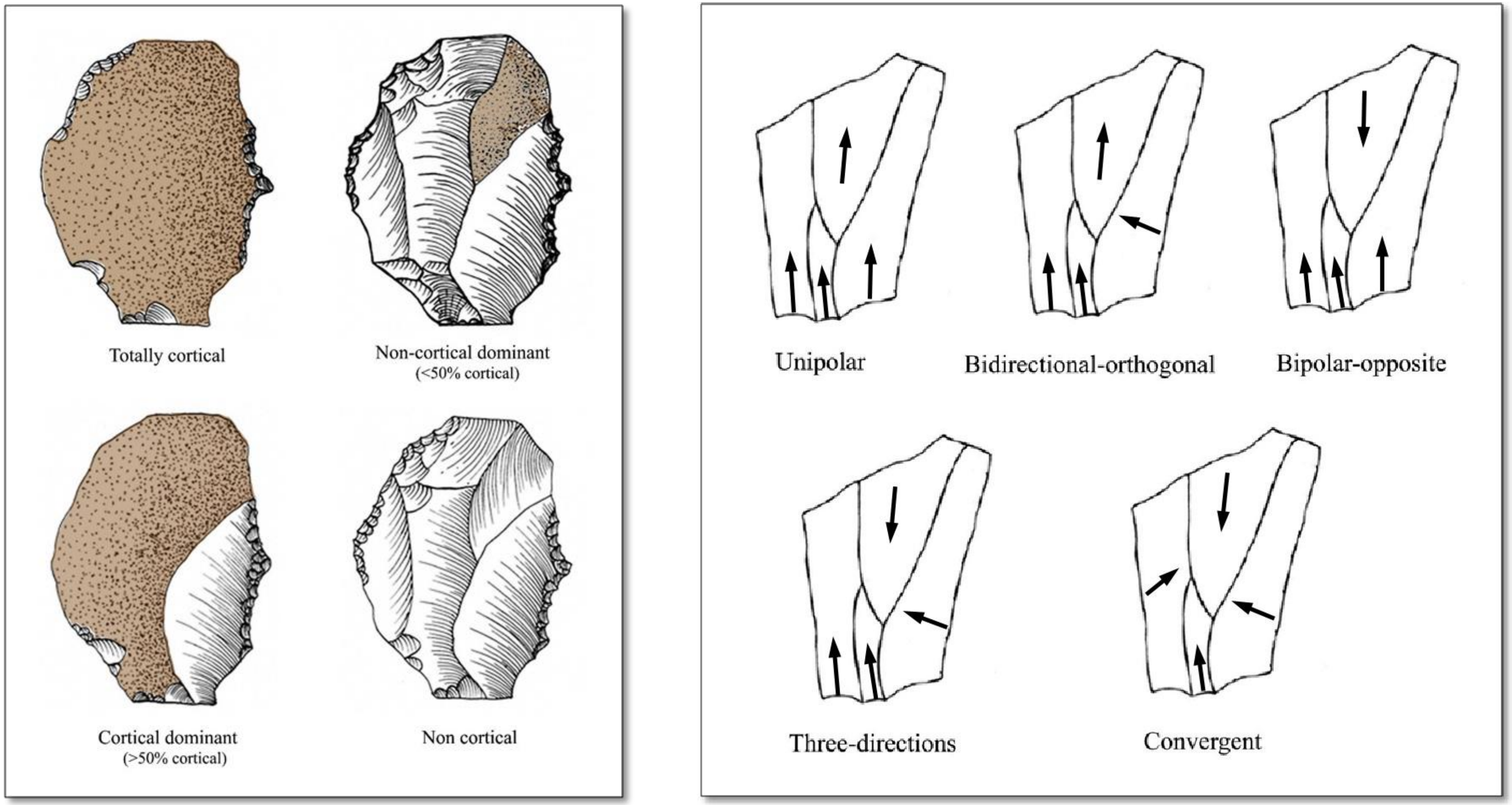
Figure 3.4.3.3 Illustration of the main types of butt or striking platform of the flakes

4) Dorsal face

Amount of cortex	***Direction of scars***	***Number of scars***	***Number of arrises***
- Totally cortical - Cortical dominant *(>50% cortical)* - Non-cortical dominant *(<50% cortical)* - Non cortical - Undetermined	- Unipolar - Bipolar-opposite - Bidirectional-orthogonal - Three-directions - Convergent - Undetermined - Absent	- 1 scar - 2 scars - 3 scars - 4 scars - 5 scars - 6 scars - 7 scars - 8 scars - > 9 scars	- 1 arrise - 2 arrises - 3 arrises - 4 arrises - 5 arrises - 6 arrises - 7 arrises - 8 arrises - > 9 arrises

Extent of cortex on the dorsal face of the flakes provides indications regarding the degree of exploitation of the cores from which they are removed. A flake with a totally cortical dorsal face is the first one to be removed; if it has, moreover, a cortical butt it is a first flake to be removed from the core, at the beginning of the reduction sequence. Progressively the cortex goes as the reduction progresses and then the flakes show less and less cortex **(figure 3.4.3.4a)**.

The direction of the scars indicates the method of exploitation, *i.e.* how the core was managed during its reduction and whether it was struck from one striking platform (unidirectional scars), two platforms (bidirectional scars) or several platforms (multidirectional scars) **(figure 3.4.3.4b)**. Complementary information is provided by counting the number of scars and of arrises between the scars.



a) Amount of cortex b) Direction of scars

Figure 3.4.3.4 Illustration of the characters of the dorsal face of flakes: a) amount of cortex; b) direction of scars

5) General morphology

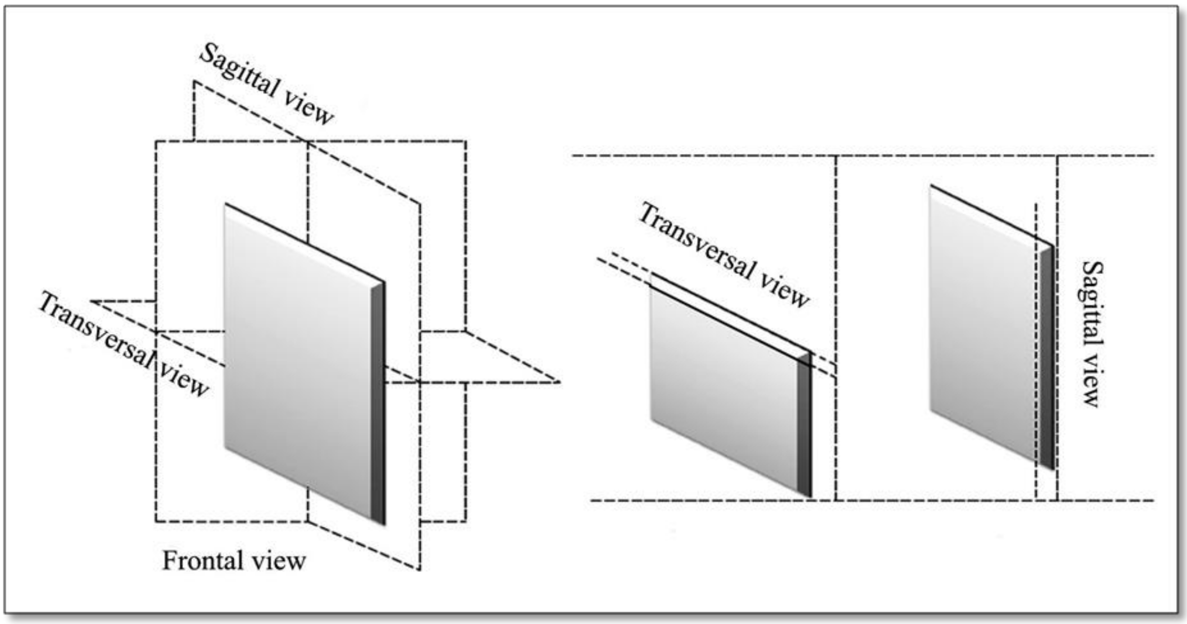


Figure 3.4.3.5 The planes for the description of the objects volume, showing the frontal, sagittal and transversal views

Frontal view	*Sagittal view*	*Transversal view*
- Almond - Bi-convex - Quadrangular - Circular - D-shape - Ellipse - Polygonal - Irregular - Oval - Pentagonal - Right triangular - Triangular - Trapezoidal	- Almond - Bi-convex - Quadrangular - Circular - D-shape - Ellipse - Polygonal - Irregular - Oval - Pentagonal - Right triangular - Triangular - Trapezoidal	- Almond - Bi-convex - Quadrangular - Circular - D-shape - Ellipse - Polygonal - Irregular - Oval - Pentagonal - Right triangular - Triangular - Trapezoidal

The general morphology of the flakes is observed according to the frontal, sagittal, and transversal views **(figure 3.4.3.5)**. It allows to precisely describe the shape of the flakes **(figure 3.4.3.6)** and to find out whether some particular shapes are more frequent and if they imply some template in the knapper’s mind.

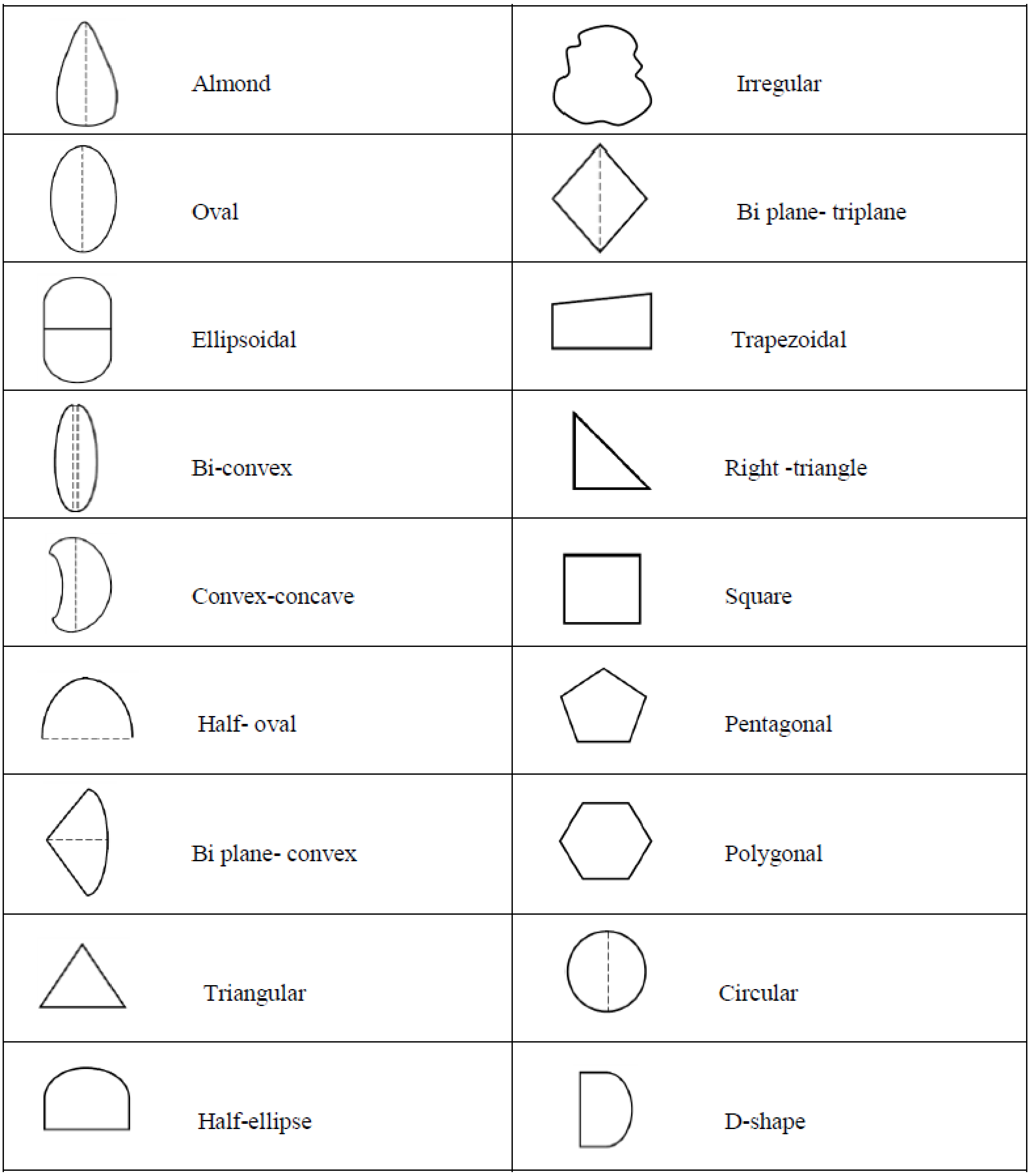


Figure 3.4.3.6 Representation of the various shapes, shown on the frontal, sagittal and transversal views

6) Angle of edges

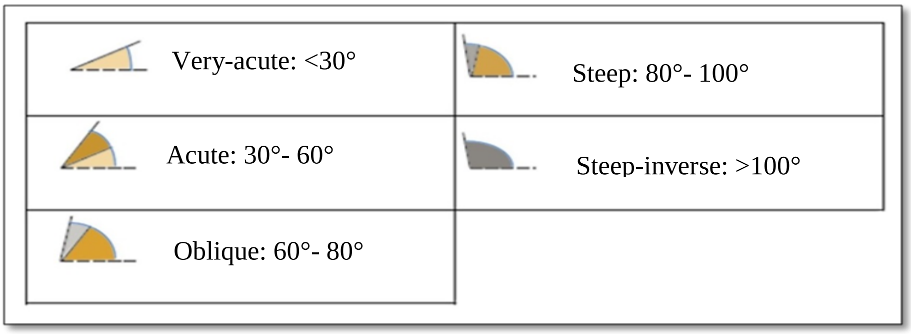


Figure 3.4.3.7 Illustration of the angle categories used to describe the flake edges on the right, left, distal and proximal sides

The angle of flake edges is examined and classified in the same pattern as the butt angle **(figure 3.4.3.7)**. It refers to the possible use of the flake, as an acute edge may be efficient in cutting and a steep edge may be the better place where to hold the flake.

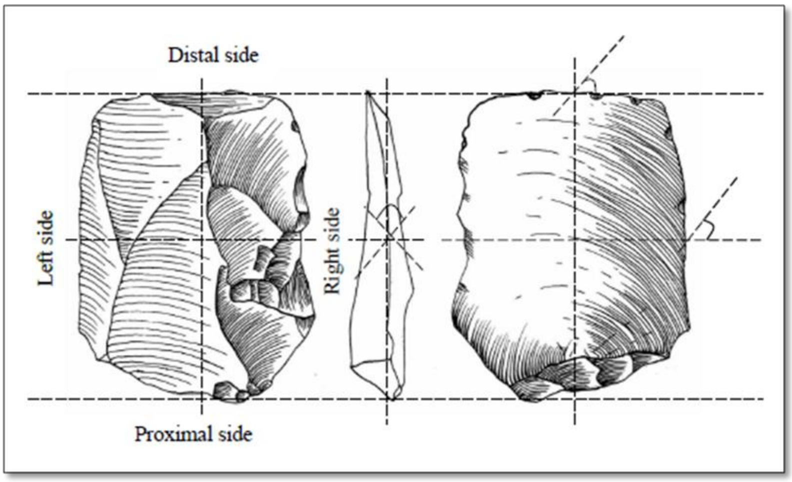


Figure 3.4.3.8 Distribution of the angle of edges of flakes, represented on the right, left, distal and proximal sides

7) Damage of the edges

The edges are sometimes damaged, either due to use or due to any other factor at the time of site occupation or later (taphonomic process). These damages are classified as chipping or pounding. Of course it would be interesting to distinguish the use damage but it seems difficult. Careful observation of the lateral, distal and proximal sides **(figure 3.4.3.8)** provides statistical data that may help in solving this question.

ANALYSIS OF FLAKES
SITE: Tham Lod Rockshelther, Pang Mapha (North-western Thailand)
EXCAVATOR: Prof. Rasmi Shoocongdej
COLLECTOR: Tham Lod Rockshelter/ Area II (S20W21)
DATE: TL´45

No.	LEVEL	GRID	STRATIGRAPHIC LAYER	RAW MATERIALS	TYPE OF ARTEFACT	MEASUREMENTS			VENTRAL OR LOWER FACE	BUTT			DORSAL OR UPPER FACE				GENERAL MORPHOLOGY							DAMAGE OF THE EDGE			
						Length	Breadth	Thickness	Type of Bulb	Corticality	Type of Butt (including facets)	Angle of Butt	Amount of Cortex	Number of scars	Arrises	Direction of Scars	Frontal	Sagittal	Transversal	Angle of right side	Angle of left side	Angle of distal side	Angle of proximal side	Right	Left	Distal	Proxi-
1	760-740	seq 3	10	black sand	flake	33	54	13	d	nco	lin	si	co-d	3	3	unipo	trg (3)	trp (4)	trg (3)	o	s	a	si				
2	760-740	seq 3	10	black sand	flake	28	38	8	m	co-d	lin	s	nco	5	4	bipo-op	ov	bi-c	rg (3)	s	s	s	si				
3	760-740	seq 3	10	black sand	flake	22	25	5	m	nco	pun	a	nco	3	3	unde-	bi-c	irre-	irre-	a	va	va	va				
4	760-740	seq 3	10	black sand	flake	21	24	9	d	nco	pla	s	co-d	2	3	unipo	trp (4)	trp (4)	trg (3)	a	a	a	si				
5	760-740	seq 3	10	black sand	flake	29	30	10	d	co	pla	s	nco-d	unde	unde	unde-	ptg (5)	trp (4)	rg (3)	va	s	o	s				
6	760-740	seq 4	10	black sand	flake	26	30	12	d	nco	pun	s	nco	2	1	unipo	irre-	trg (3)	irre-	o	o	s	s				
7	760-740	seq 3	10	quartzite	flake	41	65	19	d	nco	pun	a	nco	5	4	conv	ov	trg (3)	ov	a	a	si	a				
8	780-760	seq 4	10	sandstone	flake	67	78	41	m	co	pla	s	co	3	2	unipo	cir	trg (3)	trg (3)	a	s	s	s				

Table 3.4.3.2 Example of the chart used for analysis of flakes

3.4.4 Criteria for Tools (large and small tools) Analysis

Type of tool	
Small tools	***Large tools***
Scraper Denticulate Pointed tool Atypical small tool Small sumatralith Small Partial sumatralith Small Unifacial discoid	End chopper Side chopper Other choppers Sumatralith Partial sumatralith (unifacial) Partial sumatralith (bifacial) Unifacial discoid

Measurements			
- Length in mm	- Width in mm	- Thickness in mm	- Weight in gram

Support / Blank	
- Whole cobble - Split cobble- - Broken cobble - Cobble fragment - Indeterminate cobble - Flake - Fragment	- Whole pebble - Split pebble - Broken pebble - Pebble fragment - Indeterminate cobble

General morphology		
Frontal view	***Sagittal view***	***Transversal view***
- Almond - Convex-concave - D-shape - Ellipse - Half-ellipse - Half-oval - Irregular - Oval - Pentagonal - Triangular - Trapezoidal	**1. Delineation of the edges** - Incurvated - Straight - Sinuous **2. Symmetry of tools** - Symmetrical - No-symmetrical	- Almond - Bi-convex - D-shape - Ellipse - Half-ellipse - Half-oval - Irregular - Oval - Pentagonal -Triangular - Trapezoidal

Type of shaping
- Unifacial - Bifacial

Shaping (on each of the upper and lower faces)				
Amount of cortex	***Number of removals***	***Direction of removals***	***Length of the longest removals***	***Extent of removals***
- Totally cortical - Cortical dominant *(>50% cortical)* - Non-cortical dominant *(<50% cortical)* - Non cortical - Absent - Undetermined	- 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 - >10	- Unipolar - Bipolar-opposite - Bidirectional-orthogonal - Three-directions - Convergent - Undetermined - Absent	- (1-10 mm) - (11-20 mm) - (21-30 mm) - (31-40 mm) - (41-50 mm) - (51-60 mm) - (61-70 mm) - (71-80 mm) - > (80 mm)	- Marginal - Extensive - Very extensive - Total - Undetermined

<table>
<tr><th colspan="12">Morpho-functional features</th></tr>
<tr><th colspan="4">Nature of the edges</th><th colspan="4">Angle of the edges</th><th colspan="4">Frontal view of the edges</th></tr>
<tr><td colspan="4">- Cortex
- Fracture
- Scraper unifacial
- Scraper bifacial
- Removals unifacial
- Removals bifacial
- Notch
- Point
- Beak</td><td colspan="4">- Very-acute: <30°
- Acute: 30º-60º
- Oblique: 60º-80º
- Steep: 80º-100º
- Steep-inverse: >100º</td><td colspan="4">- Straight
- Convex
- Concave
- Dihedral
- S-shape
- Regular
- Denticulated
- Pointed
- Nosed
- Irregular</td></tr>
<tr><th colspan="12">Retouch of edges</th></tr>
<tr><th colspan="3">Location of Retouch</th><th colspan="3">Extent of retouch</th><th colspan="3">Direction of Retouch</th><th colspan="3">Position of Retouch</th></tr>
<tr><td colspan="3">- Right side
- Left side
- Distal side
- Proximal side</td><td colspan="3">- Marginal
- Extensive
- Very-extensive
- Total</td><td colspan="3">- Direct
- Inverse
- Alternate
- Bifacial</td><td colspan="3">- Distal
- Mesial
- Proximal
- Right
- Left
- Total</td></tr>
<tr><th colspan="12">Damage of the edges</th></tr>
<tr><td colspan="4">- Pounding</td><td colspan="4">- Chipping</td><td colspan="4">- Both (pounding & chipping)</td></tr>
</table>

Table 3.4.4.1 Criteria for the analysis of the tools (large and small tools) (Modified from Xosé Pedro Rodriguez 2004)

1) Type of tool

Many different types of tools have been identified in the assemblages from Tham Lod Rockshelter.

Among small tools, these types are: End scraper, Side scraper, Double scraper, Multiple scraper, Nosed scraper, Beak scraper, Denticulate, Pointed tool, Atypical small tool, Small sumatralith, Small partial sumatralith and Small unifacial discoid. For the large tools, the different types are: End chopper, Side chopper, Double chopper, Multiple chopper, Corner chopper, Nosed chopper, Steep chopper, Denticulate chopper, Extended chopper, Giant chopper, Pointed large tool, Sumatralith, ½ Sumatralith, ¾ Sumatralith, Partly bifacial tool and Unifacial discoid.

As these types are represented by very few specimens, they are grouped into tool categories as follows:

Small tools	*Large tools*
Scraper	End chopper
Denticulate	Side chopper
Pointed tool	Other choppers
Atypical small tool	Sumatralith
Small sumatralith	Partial sumatralith (unifacial)
Small Partial sumatralith	Partial sumatralith (bifacial)
Small Unifacial discoid	Unifacial discoid

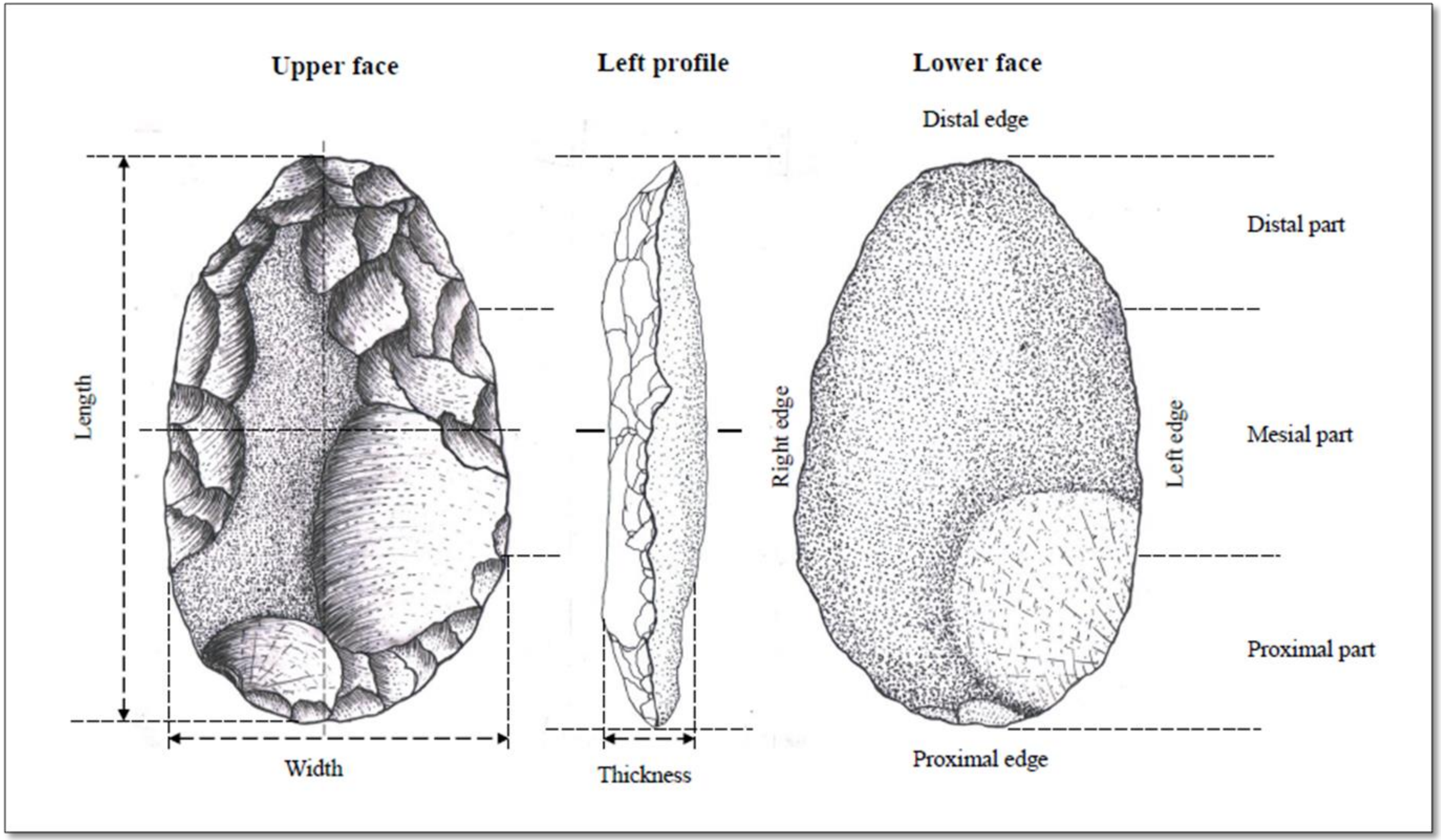


Figure 3.4.4.1 The dimension of the tools (large and small tools): length, width and thickness

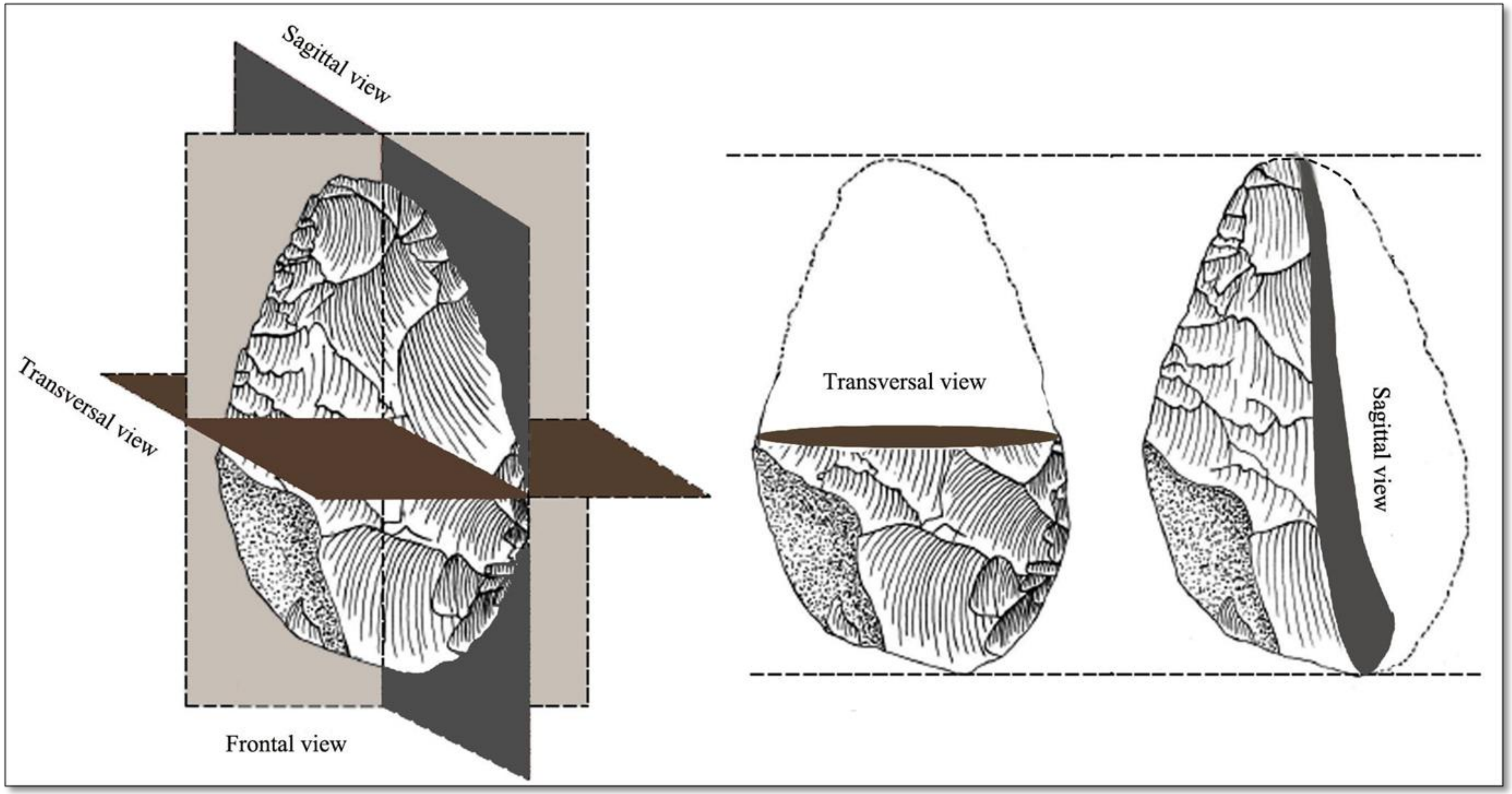


Figure 3.4.4.2 The planes for the description of the objects' volume (large and small tools), shown in the frontal, sagittal and transversal views (Modified from Rodriguez 2004)

2) Dimensions of tools (large and small tools)*:* Measurement

The orientation of the proper tools (large and small tools) is made according to the longest dimension which defines the longitudinal axis. The length, width and thickness of stone artefacts are measured with a Vernier Calliper **(Figure 3.4.4.1)**.

Length: The longest dimension measured from the proximal end to distal end along the central axis.

Width: The maximal dimension perpendicular to the longitudinal axis.

Thickness: The thickness is measured on the central part of the thickness mesial.

For the sumatraliths, the length is measured along the longitudinal axis, from the proximal end to the distal end and the width is the maximal dimension in perpendicular.

3) Support / Blank

Large and Small tools	
- Whole cobble - Cobble fragment - Broken cobble - Split cobble - Indeterminate cobble - Flake - Fragment	- Whole pebble - Pebble fragment - Broken pebble - Split pebble - Indeterminate pebble

The tools can be made on different types of support, either directly collected in the environment after selection of the suitable shape (i.e. cobble) or obtained by knapping a core (to get a flake) or also splitting a cobble or pebble (**figure 3.4.4.3**).

In the case of tools made on flakes (flake tools), the butt is also described as for the blank flakes **(figures 3.4.3.4 and 3.4.3.5)**.

Small tools (Light-duty tools) when made on flakes		
Corticality of butt	***Type of butt***	***Angle of butt***
- Totally cortical - Cortical dominant *(>50% cortical)* - Non-cortical dominant *(<50% cortical)* - Non cortical - Absent - Undetermined	- Plane - Linear - Punctiform - Bifacetted - Multifacetted	- Very-acute *(<30°)* - Acute *(30°-60°)* - Oblique *(60°-80°)* - Steep *(80°-100°)* - Steep-inverse *(>100°)*

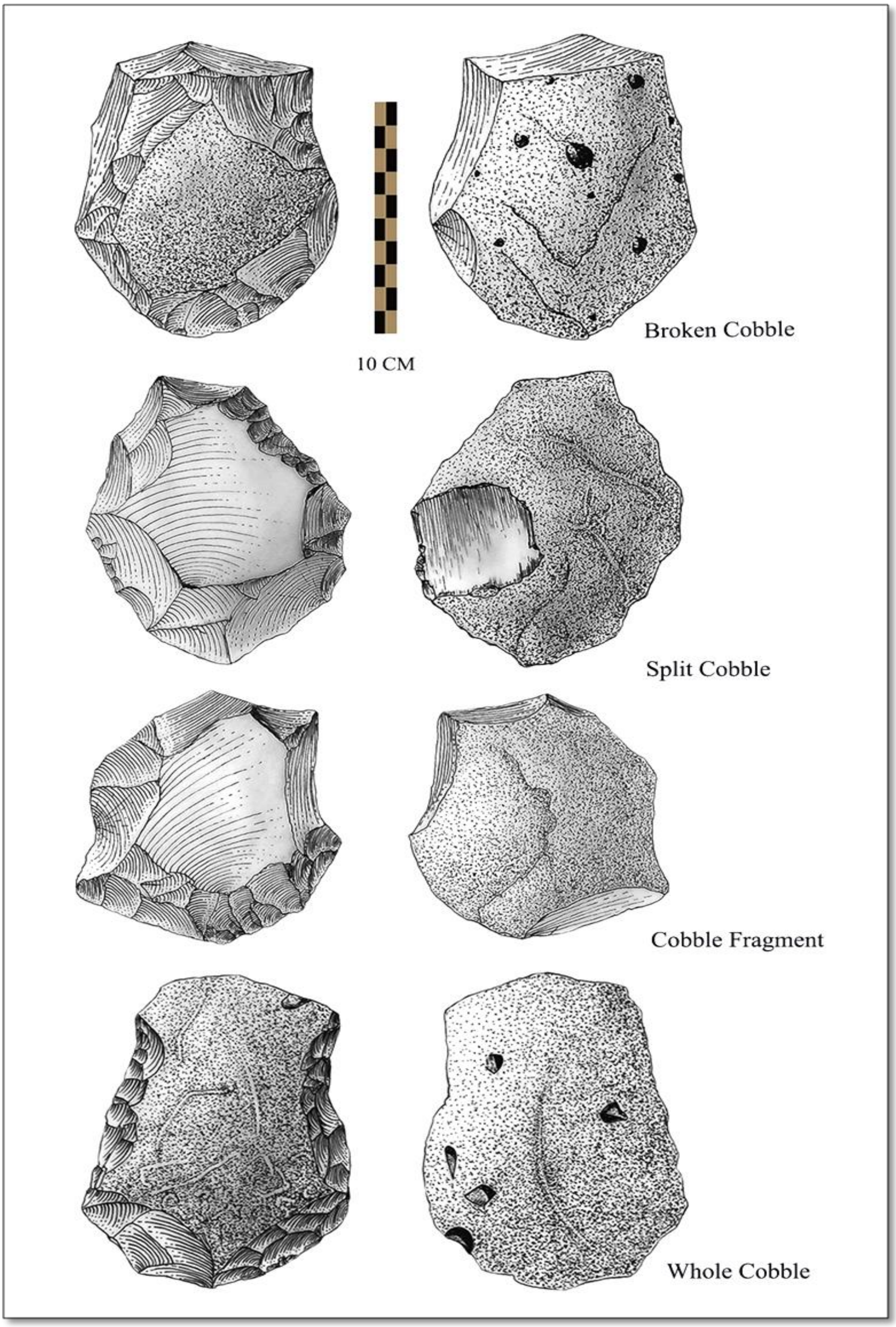


Figure 3.4.4.3 Illustration of the main supports of the tools

4) General morphology

Large and Small tools		
Frontal view	***Sagittal view***	***Transversal view***
- Almond - Convex-concave - D-shape - Ellipse - Half-ellipse - Half-oval - Irregular - Oval - Pentagonal - Triangular - Trapezoidal	**1. Delineation of the edges** - Incurvated - Straight - Sinuous **2. Symmetry of tools** - Symmetrical - No-symmetrical	- Almond - Bi-convex - D-shape - Ellipse - Half-ellipse - Half-oval - Irregular - Oval - Pentagonal - Triangular - Trapezoidal

The general morphology is analysed according to three different views: the frontal, sagittal, and transversal views **(figure 3.4.4.2)**. The frontal view is the most obvious but efficiency of a cutting edge or convenience of a handle also depends of the sagittal view or profile. The transversal view helps in evaluating the association of shapes of the edges opposite to each other on the lateral sides of the tools **(figures 3.4.4.4 & 3.4.4.5)**.

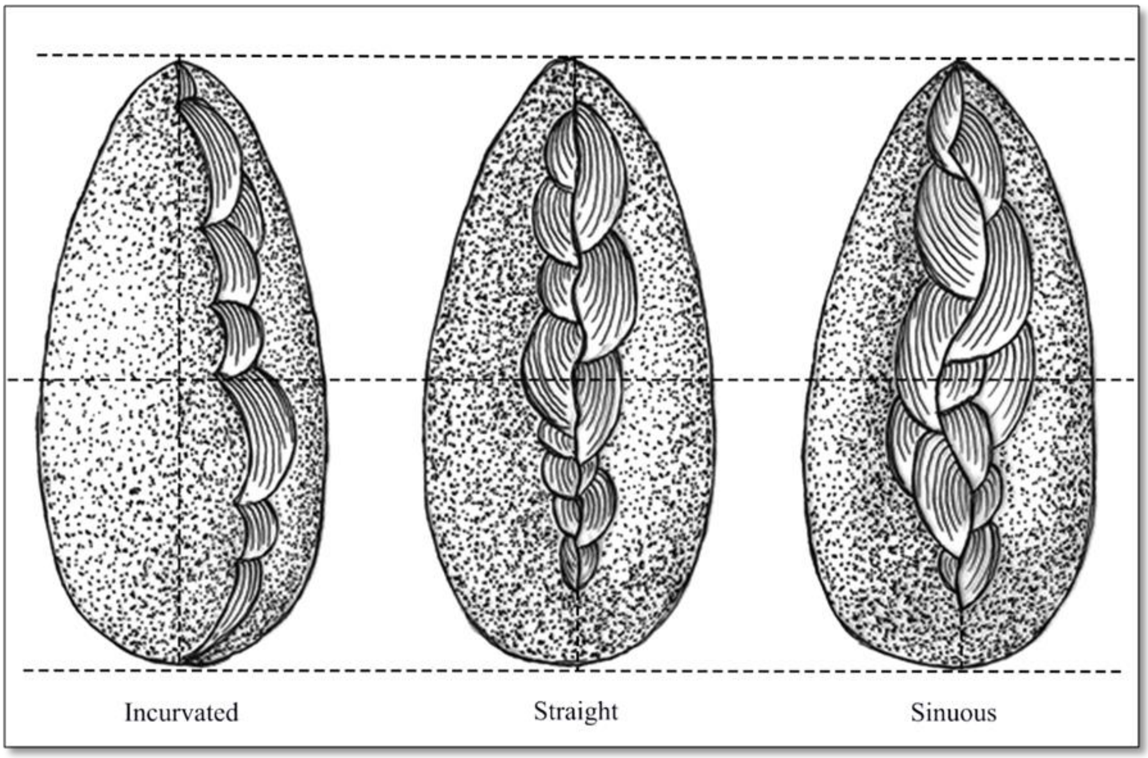


Figure 3.4.4.4 Illustration of the delineation of the edge (sagittal view), representing the incurvated, straight and sinuous (Modified from Rodriguez 2004)

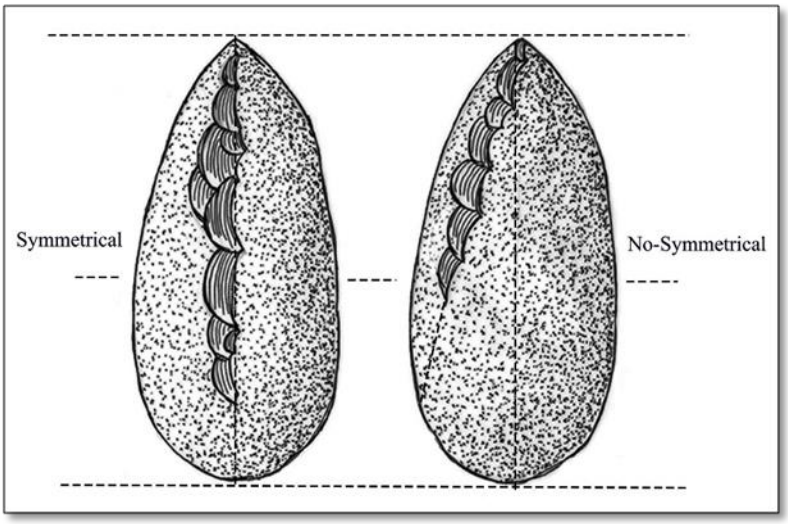


Figure 3.4.4.5 Illustration of the symmetry or non-symmetry of tools in sagittal view (Modified from Rodriguez 2004)

5) Type of shaping

Large and Small tools	
- Unifacial	**-** Bifacial

Only two main types of shaping are identified on the tools: “Unifacial” or “Bifacial”.

6) Shaping on Upper and Lower face

Large and Small tools				
Amount of cortex	*Number of removals*	*Direction of removals*	*Length of the longest removals*	*Extent of removals*
- Totally cortical - Cortical dominant *(>50% cortical)* - Non- cortical dominant *(<50% cortical)* - Non cortical - Absent - Undetermined	- 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 - >10	- Unipolar - Bipolar-opposite - Bidirectional-orthogonal - Three-directions - Convergent - Undetermined - Absent	- (1-10 mm) - (11-20 mm) - (21-30 mm) - (31-40 mm) - (41-50 mm) - (51-60 mm) - (61-70 mm) - (71-80 mm) - > (80 mm)	- Marginal - Extensive - Very extensive - Total - Undetermined

All the tools (large and small) are observed on both faces, the upper and lower face. The upper face usually showed more removals than lower face.

An amount of cortex, from "Totally cortical" to "Non cortical" **(figure 3.4.4.6)** indicates how far has been modified the original surface of the cobble/pebble or block. The number of removals more than 5 mm long (if smaller they are considered as retouch) is observed on each face and counted within the range of 1 to 10; this number provides an idea of the intensity of work involved in the shaping. The direction of removals shows how this work was organised **(figure 3.4.4.7)**. The length of the longest removals is measured (more than 5 mm to 90 mm). As a complementary information, the extent of removals is indicated qualitatively from "Very marginal" to "Very extensive" (more than half of the tool width) or even "Total" **(figure 3.4.4.8)**.

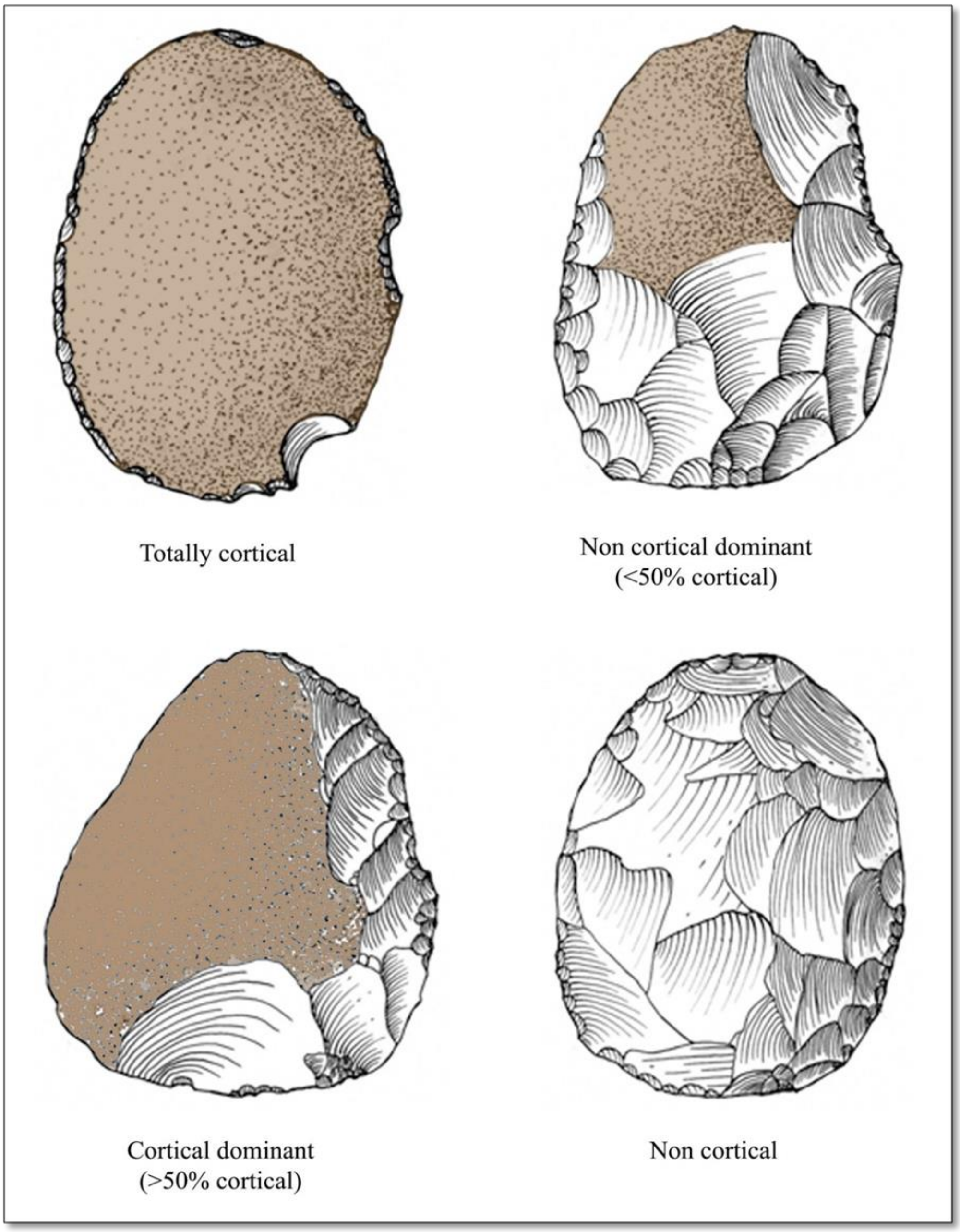


Figure 3.4.4.6 Illustration of the amount of cortex on the upper and lower faces of the tools (large and small tools)

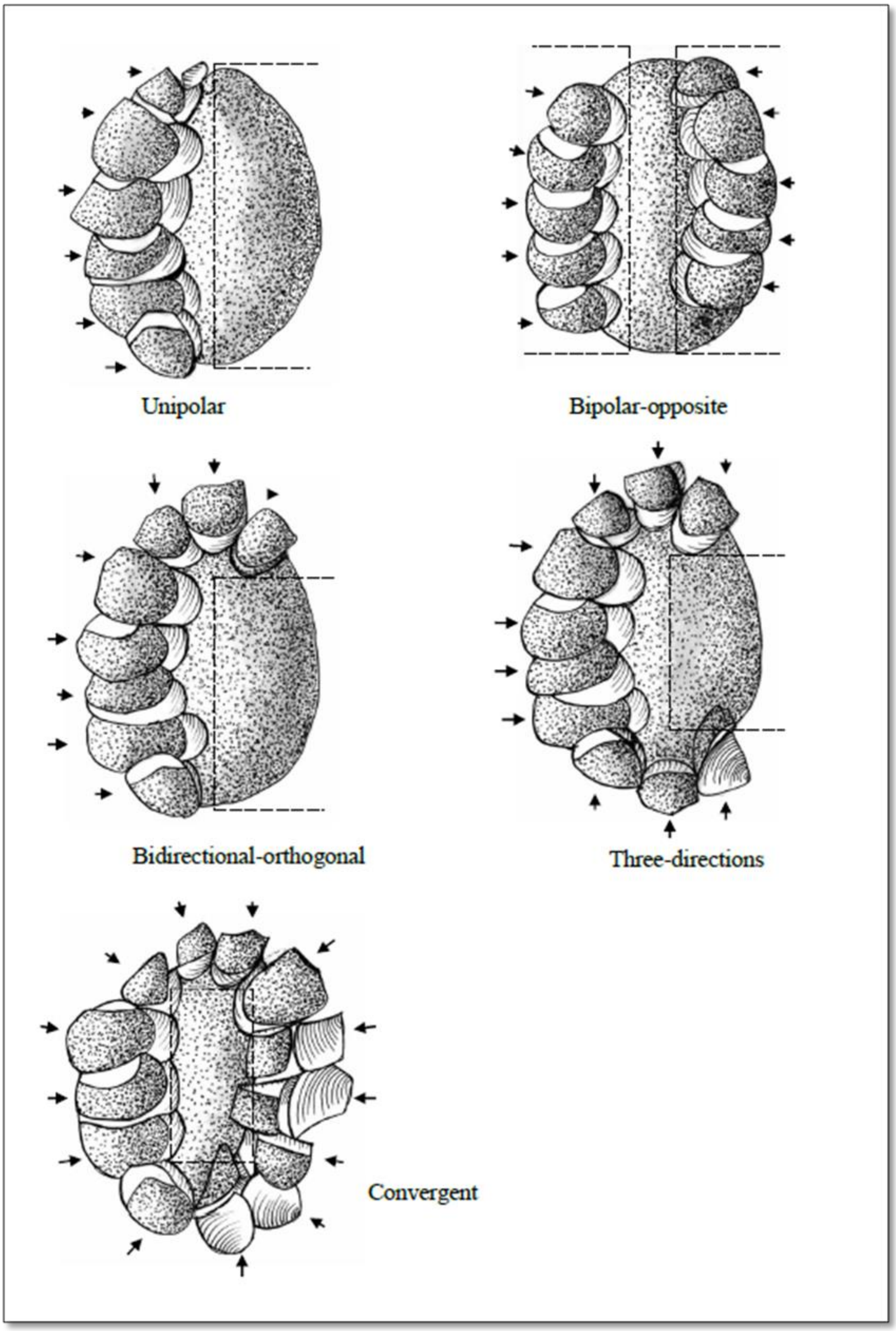


Figure 3.4.4.7 Illustration of the direction of scars on the upper and lower faces of the tools (mainly large tools)

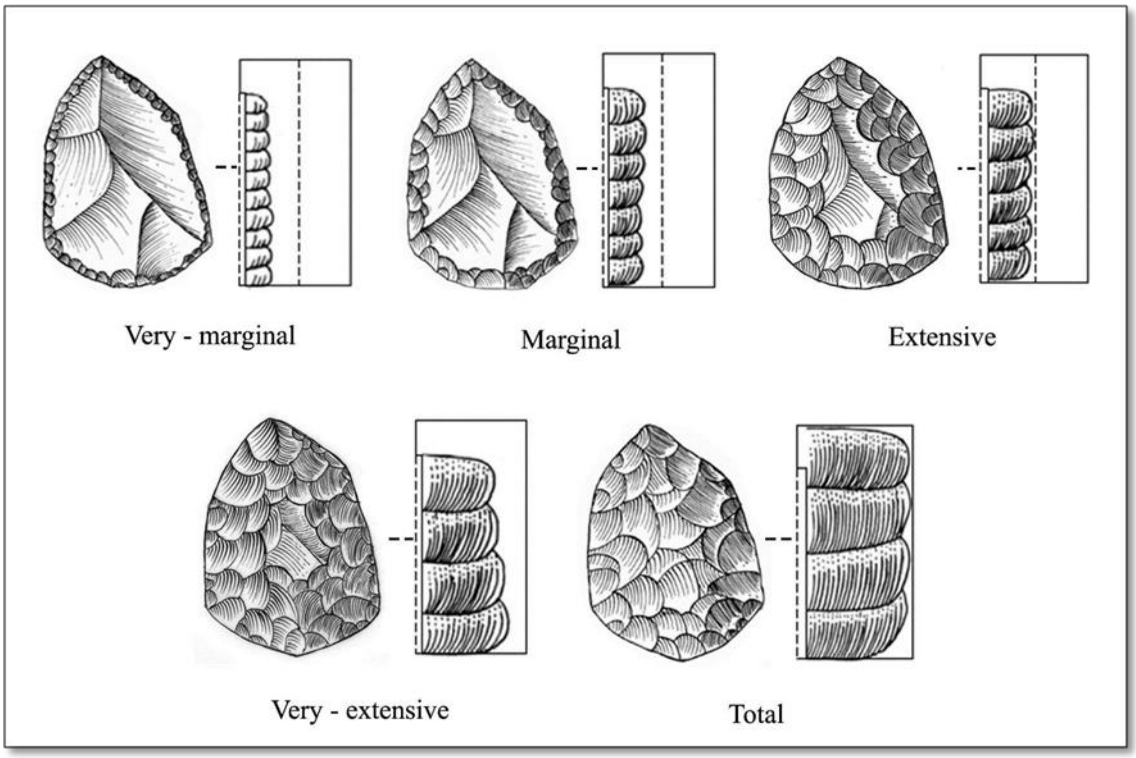


Figure 3.4.4.8 Illustration of the extension of removals or extension of retouch of the tools (large and small tools) (Referring to Rodriguez 2004 for the rectangular diagrams)

7) Morpho-functional features

Large and Small tools		
Nature of the edges	***Angle of the edges***	***Frontal view of the edges***
- Cortex - Fracture - Scraper unifacial - Scraper bifacial - Removals unifacial - Removals bifacial - Notch - Point - Beak	- Very-acute: <30° - Acute: 30º-60º - Oblique: 60º-80º - Steep: 80º-100º - Steep-inverse: >100º	- Straight - Convex - Concave - Dihedral - S-shape or convex-concave - Notch - Regular - Denticulated - Pointed - Nosed - Irregular

The nature of the edge of the tools is recorded for each of the four sides. It may be blank (cortical or fractured, assuming the fractures are not intentional) or it may be worked, rather coarsely by removals, or more precisely by retouch shaping a small a tool (scraper, notch, etc.). The angle of tool edges is classified in similar pattern as the flakes such as “very-acute”, “Acute”, “Oblique”, “Steep” or “Steep-inverses” **(figures 3.4.4.9 and 3.4.4.10)**.

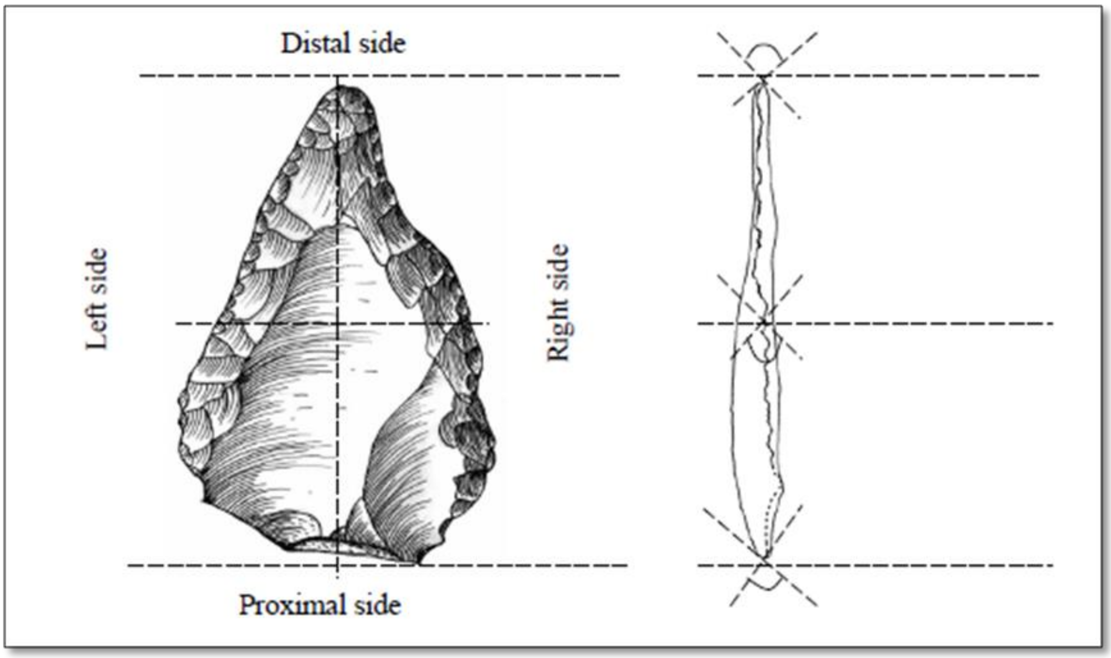


Figure 3.4.4.9 Illustration of the location where the angles of tool edges are observed (large and small tools)

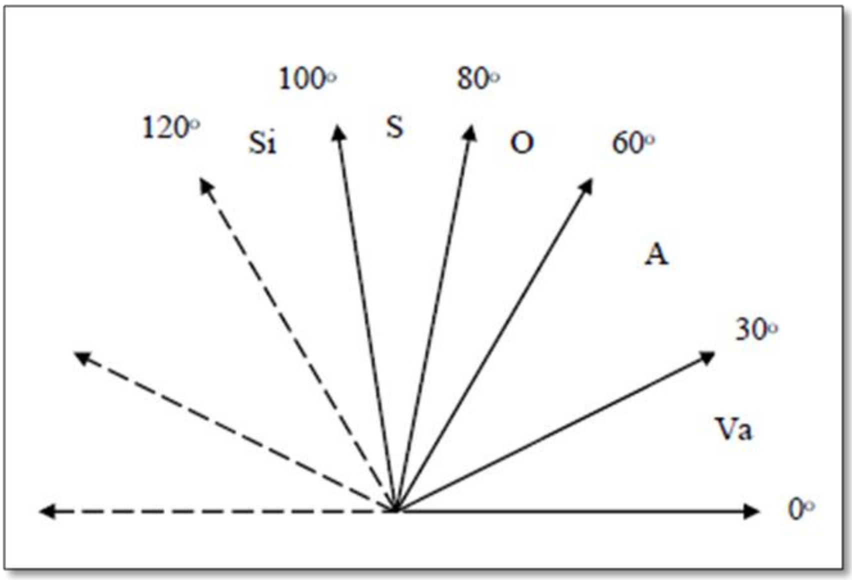


Figure 3.4.4.10 Illustration of the angle categories used for qualifying the edges of the tools (large and small tools). Va: very acute; A: acute; O: oblique/intermediate; S: steep; Si: steep inverse

The shape in frontal view of the edge is recorded for each of the four sides. It provides clues regarding the intention of Palaeolithic knappers when they were trimming the shape of their tools **(figure 3.4.4.11)**.

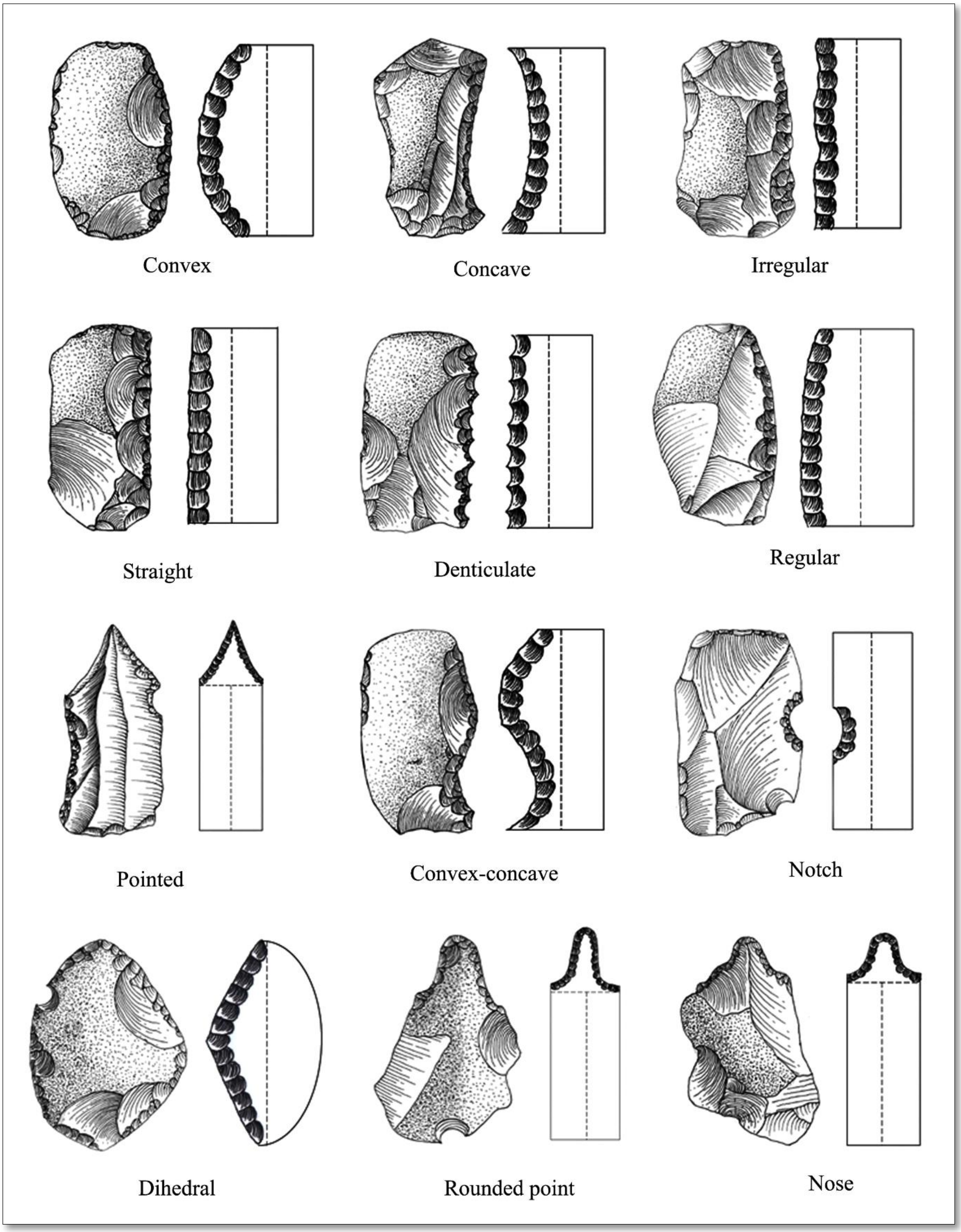


Figure 3.4.4.11 Illustration of the frontal view of the edges of the tools (large and small tools)

8) Retouched edges

Large and Small tools			
Location of Retouch	***Extent of retouch***	***Direction of Retouch***	***Position of Retouch***
- Right side - Left side - Distal side - Proximal side	- Marginal - Extensive - Very-extensive - Total	- Direct - Inverse - Alternate - Bifacial	- Distal - Mesial - Proximal - Right - Left - Total

Retouch may occur on the large tools (heavy duty-tools) for regularisation of the edges after shaping. On the small tools (light-duty tools), especially those made on flakes or debris, the retouch is usually the first modification of the blanks **(figures 3.4.4.12, 3.4.4.13 and 3.4.4.14)**. In some cases when the retouch is irregular and discontinuous it is probably not intentional and rather due to use or to some taphonomic process (like chipping: see below). If it is regular it can be supposed intentional, yet without guaranty. Its careful description may help in understanding the responsible factors and overcoming the doubts.

9) Damage of the edges

Large tools (Heavy- duty tools)
- Pounding - Chipping - Both

The damage of the edges is determined as “Pounding”, “Chipping” or “Both” (pounding & chipping) on the lateral, distal and proximal sides. These damages are considered as accidental, either due to use or to taphonmic precesses.

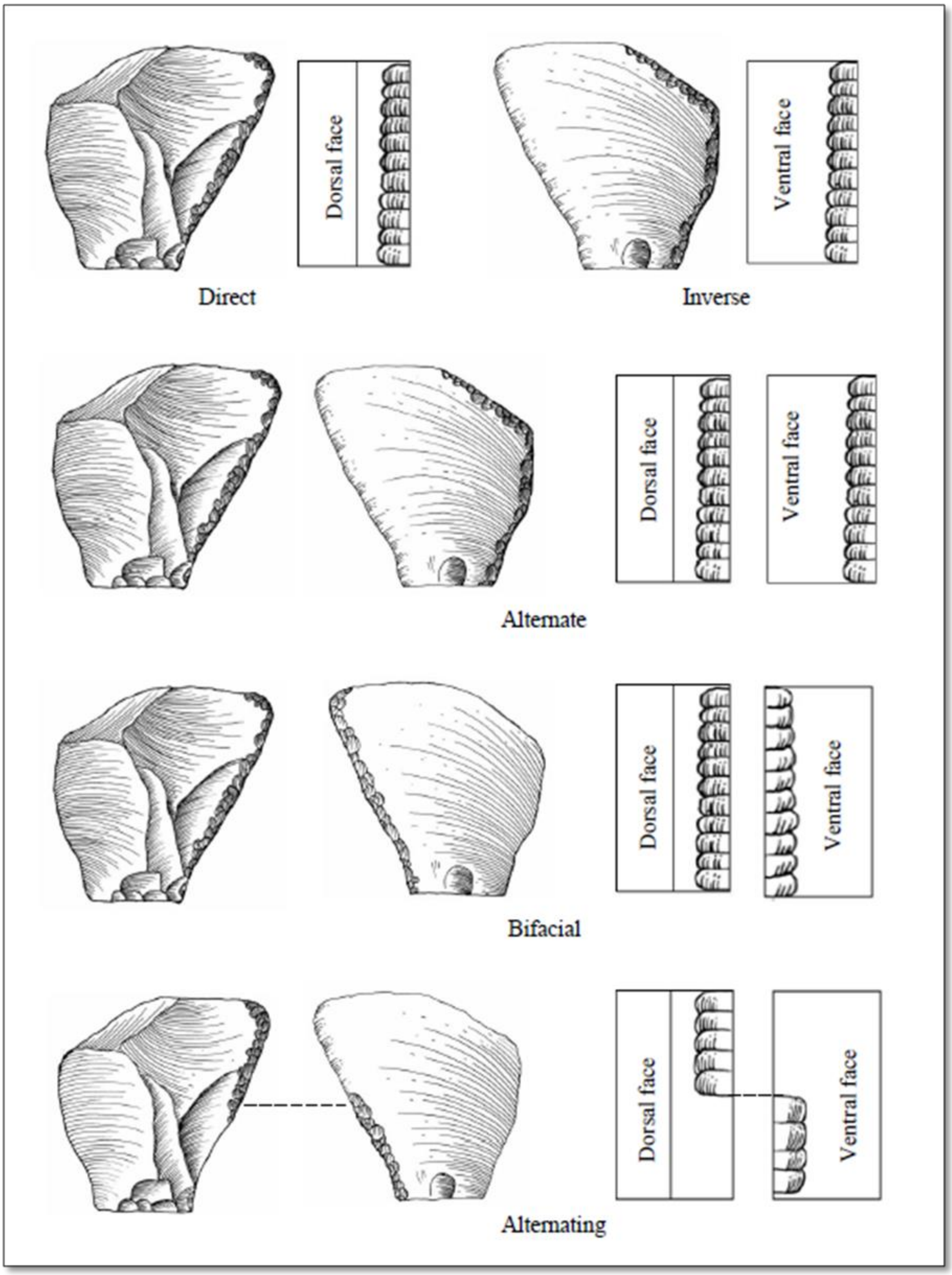


Figure 3.4.4.12 Illustration of the direction of retouch of small tools (Light-duty tools) (Referring to Rodriguez 2004 for the rectangular diagrams).

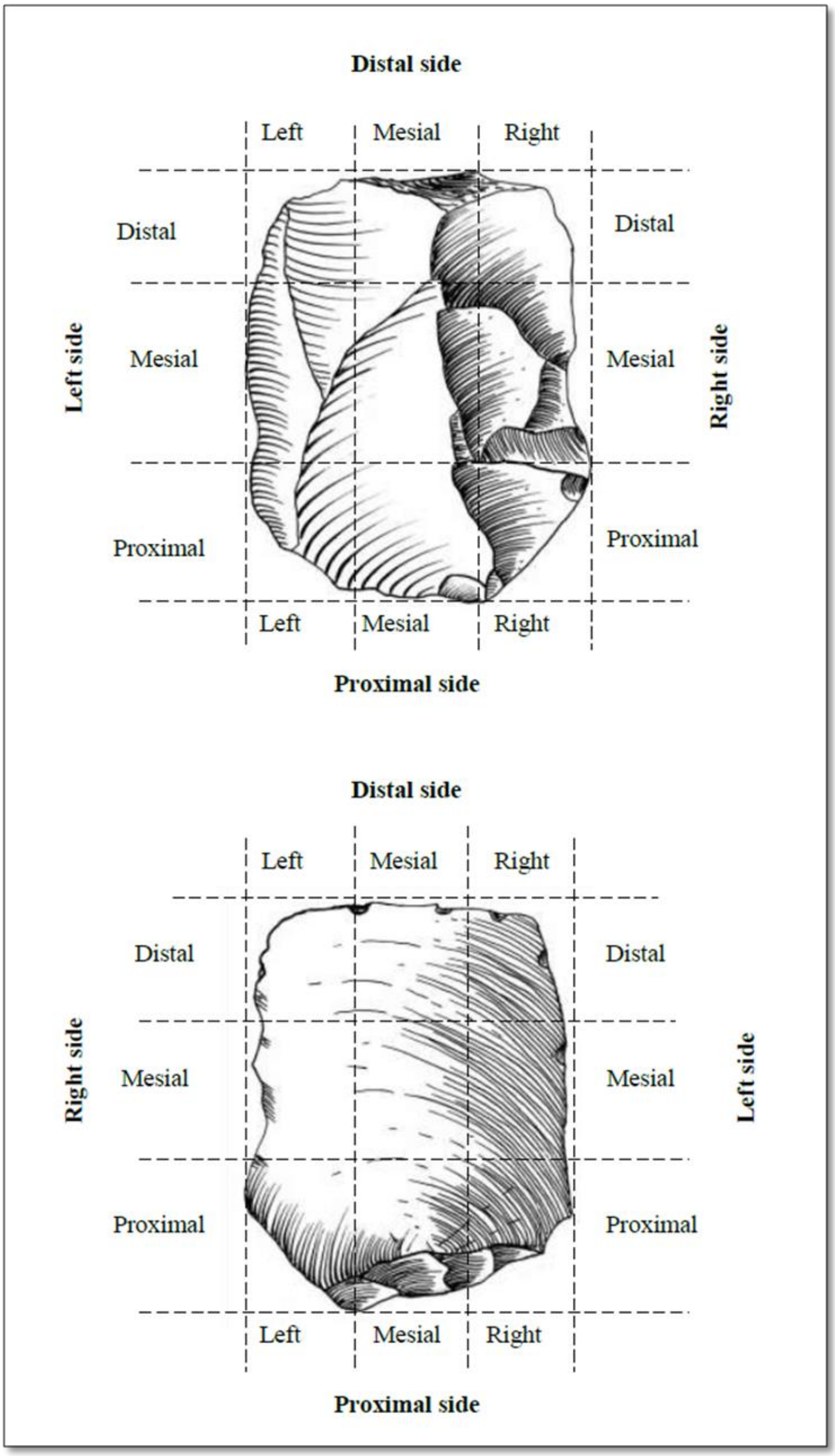


Figure 3.4.4.13 Illustration of the position of retouch on the edges of small tools (Light-duty tools

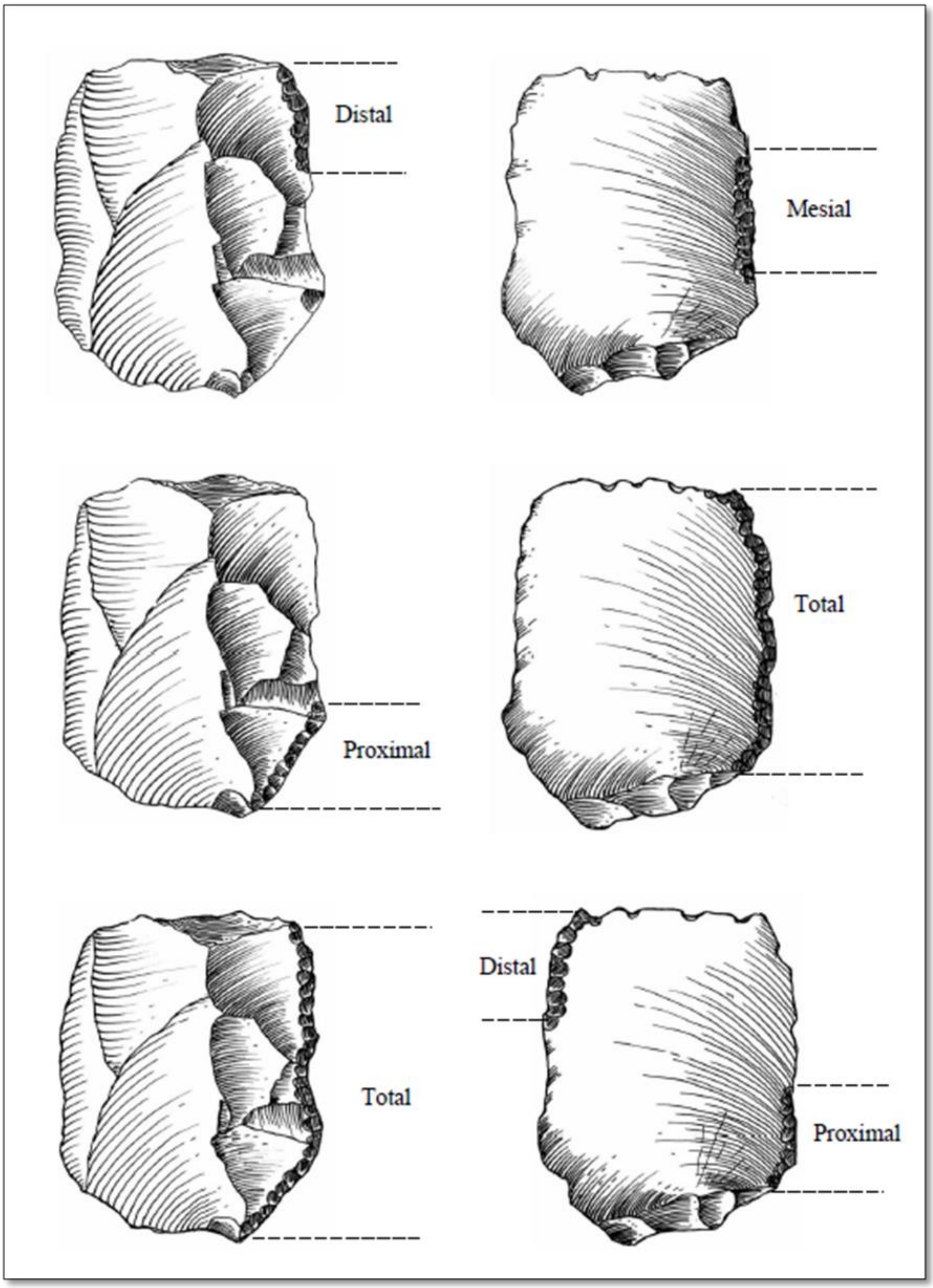


Figure 3.4.4.14 Illustration of some examples of the position of retouch on small tools (Light-duty tools) on flake

ANALYSIS OF LARGE TOOLS / HEAVY- DUTY TOOLS
SITE: Tham Lod Rockshelther, Pang Mapha (North-western Thailand)
EXCAVATOR: Prof. Rasmi Shoocongdej
COLLECTOR: Tham Lod Rockshelter/ Area II (S20W21)
DATE: TL´45

No.	LEVEL	GRID	NUMBER	ARCHEOLOGICAL UNIT	RAW MATERIAL	TYPE OF TOOL	BLANK	TYPE OF SHAPING	MEASUREMENT				GENERAL MORPHOLOGY				UPPER FACE					LOWER FACE				
								Shaping of tools	Lenght	Breadth	Thickess	Weight (g)	Frontal view	Sagittal view		Transversal view	Amount of cortex	Number of removals shaping the tool	Direction of removals	length of the longest removals	Extent of removals	Amount of cortex	Number of removals shaping the tool	Direction of removals	Length of the longest removals	Extent of removals
														Delinea	Symmetry of tool											
1	760-740	seq 3	10976	1	sandstone	extended	cobble	unifacial	123	127	37	750	almond	inc	no-sym	bi-cx	co-d	1	unipo	97	e	co-d	1	unipo	30	m
2	760-740	seq 3	10981	1	sandstone	double ch	cobble/B	unifacial	153	87	70	1500	trp	inc	no-sym	trg	nco-d	1	unipo	71	m	co				
3	760-740	seq 3	10976	1	sandstone	end chopp	cobble/B	unifacial	126	107	61	1480	ellip	rt	sym	almond	nco-d	>12	conv	70	e	co				
4	760-740	seq 3	10952	1	quartzite	end chopp	cobble/B	unifacial	109	51	44	1040	trp	rt	sym	trp	nco-d	5	bipo-ort	51	ve	nco				
5	760-740	seq 3	10984	1	sandstone	giant chop	boulder	unifacial	248	119	92	900	trg	inc	no-sym	oval	nco-d	2	unipo	62	e	co-d				

Table 3.4.4.2a Example of the chart used for analysis of large tools (Heavy-duty tools), part 1

ANALYSIS OF LARGE TOOLS / HEAVY- DUTY TOOLS
SITE: Tham Lod Rockshelther, Pang Mapha (North-western Thailand)
EXCAVATOR: Prof. Rasmi Shoocongdej
COLLECTOR: Tham Lod Rockshelter/ Area II (S20W21)
DATE: TL´45

No.	LEVEL	GRID	NUMBER	ARCHEOLOGICAL UNIT	RAW MATERIAL	TYPE OF TOOL	BLANK	TYPE OF SHAPING	ANGLE OF THE EDGE				NATURE OF THE EDGE				FRONTAL VIEW OF THE EDGE				RETOUCHING OF THE EDGE				DAMAGE OF THE EDGE			
								Shaping of tools	Right side	Left side	Distal side	Proximal side	Right side	Left side	Distal side	Proximal side	Right side	Left side	Distal side	Proximal side	Right side	Left side	Distal side	Proximal side	Right side	Left side	Distal side	Proximal side
1	760-740	seq 3	10976	1	sandstone	extended	cobble	unifacial	o	o	o	si	cort	rem/uni	point	cort	cc	denticulate	nose	rt							chipping	
2	760-740	seq 3	10981	1	sandstone	double ch	cobble/B	unifacial	si	s	o	s	cort	cort	rem/uni	cort	cc	cx	beak	rt					picking			picking
3	760-740	seq 3	10976	1	sandstone	end chopp	cobble/B	unifacial	s	s	s	s	rem/uni	cort	rem/uni	rem/uni	cc	cx	cx	cx								picking
4	760-740	seq 3	10952	1	quartzite	end chopp	cobble/B	unifacial	o	s	o	s	cort	rem/uni	rem/uni	cort	cc	s-shape	cx	denticulate						picking	picking	
5	760-740	seq 3	10984	1	sandstone	giant chop	boulder	unifacial	si	s	si	o	cort	fract	rem/uni	rem/uni	cc	s-shape	cx	cx		retouch						

Table 3.4.4.2b Example of the chart used for analysis of large tools (Heavy-duty tools), part 2

ANALYSIS OF SMALL TOOLS / LIGHT-DUTY TOOLS
SITE: Tham Lod Rockshelther, Pang Mapha (North-western Thailand)
EXCAVATOR: Prof. Rasmi Shoocongdej
COLLECTOR: Tham Lod Rockshelter/ Area II (S20W10)
DATE: TL´45

No.	LEVEL	GRID	NUMBER	STRATIGRAPHIC LAYER	RAW MATERIAL	TYPE OF TOOL	BLANK	TYPE OF SHAPING	MEASUREMENTS				LOWER FACE							UPPER FACE				GENERAL MORPHOLOGY				ANGLE OF THE EDGE			
								Shaping of tools	Lenght	Breadth	Thickess	Weight (g)	Corticality (Butt)	Type of Butt	Angle of Butt	Amount of cortex	Number of scares	Length of the longest removal	Direction of removals	Amount of cortex	Number of scares	Direction of removals	length of the longest removal	Frontal view	Sagittal view		Transversal view	Right side	Left side	Distal side	Proximal side
																								Delineation of ymmetry of the tool							
1	780-760	seq 4	11129	10	sandstone	pointed to	pebble/E	unifacial	85	70	46	275				co-d				nco-d	5	three	60	trg	rt	no-sym	trp	o	o	o	si
2	760-740	seq 3	27	10	sandstone	denticulate	flake	unifacial	73	36	23	80	co	pla	s	nco				co	1	unipo	20	trg	inc	no-sym	trp	o	o	s	o
3	760-740	seq 3	29	10	black san	pointed to	pebble/E	unifacial	76	51	29	100				nco				nco	unde-	unipo	17	bi-plane	rt	sym	trp	s	s	a	s
4	760-740	seq 3	30	10	sandstone	double sc	flake	bifacial	82	57	34	155	co	pla	s	nco	2	67	unipo	co-d	1	unipo	34	trg	enticula	sym	irre	o	o	a	o
5	760-740	seq 3	10967	10	sandstone	side scrap	flake	unifacial	90	39	20	110	co	pla	o	co				co-d	1	unipo	65	irre	inc	no-sym	oval	a	o	a	o

Table 3.4.4.3a Example of the chart used for analysis of small tools (Light-duty tools), part 1

ANALYSIS OF SMALL TOOLS / LIGHT-DUTY TOOLS
SITE: Tham Lod Rockshelther, Pang Mapha (North-western Thailand)
EXCAVATOR: Prof. Rasmi Shoocongdej
COLLECTOR: Tham Lod Rockshelter/ Area II (S20W10)
DATE: TL´45

No.	LEVEL	GRID	NUMBER	STRATIGRAPHIC LAYER	RAW MATERIAL	TYPE OF TOOL	BLANK	TYPE OF SHAPING	NATURE OF THE EDGE				FRONTAL VIEW OF THE EDGE				EXTENT OF THE RETOUCH				DIRECTION OF RETOUCH				RETOUCHING OF THE EGDE				REDENNING
								Shaping of tools	Right side	Left side	Distal side	Proximal side	Right side	Left side	Distal side	Proximal side	Right side	Left side	Distal side	Proximal side	Right side	Left side	Distal side	Proximal side	Right side	Left side	Distal side	Proximal side	Burning
1	780-760	seq 4	11129	10	sandstone	pointed to	pebble/E	unifacial	rem/uni	ram/uni	pointed	cort	rt	s-shape	pointed	rt													
2	760-740	seq 3	27	10	sandstone	denticulat	flake	unifacial	fract	rem/uni	fract	cort	cx	deticulate	dihedron	rt		e				inverse				retouch			
3	760-740	seq 3	29	10	black san	pointed to	pebble/E	unifacial	fract	cort	pointed	rem/un	cx	cx	pointed	trg			m				direct						
4	760-740	seq 3	30	10	sandstone	double sc	flake	bifacial	cort	craper/u	pointed	rem/un	cx	rt	pointed	cx													
5	760-740	seq 3	10967	10	sandstone	side scrap	flake	unifacial	rem/uni	cort	fract	cort	rt	s-shape	dihedron	rt													

Table 3.4.4.3b Example of the chart used for analysis of small tools (Light-duty tools), part 2

3.4.5 Criteria for Core Analysis

Measurements			
- Length in mm	- Width in mm	- Thickness in mm	- Weight in gram

General morphology		
Number of faces	***Exploitation of the cores***	***General shape of contour***
- 2 faces - 3 faces - 4 faces - 5 faces - 6 faces	- Monofacial - Bifacial - Trifacial - Multifacial	- Almond - Quadrangular - Bi-convex - D-shape - Ellipse - Half -ellipse - Half- oval - Oval - Irregular - Triangular - Trapezoidal - Pentagonal

Upper and Lower faces				
Amount of cortex	***Number of scars***	***Direction of scars***	***Extent of removals***	***Striking platform***
- Totally cortical - Cortical dominant *(>50% cortical)* - Non-cortical dominant *(<50% cortical)* - Non cortical	- 1 scar - 2 scars - 3 scars - 4 scars - 5 scars - 6 scars - > 6 scars	- Unipolar - Bipolar-opposite - Bidirectional-orthogonal -Three-directions - Convergent - Absent - Undetermined	- Marginal - Extensive -Very extensive - Total - Undetermined	- Cortex - Removal - Fracture - Undetermined

Retouch			
Direction of retouch	***Extent of retouch***	***Location of retouch***	***Angle of the edge with retouch***
- Direct - Inverse - Alternative - Alternating - Bifacial	- Marginal - Extensive - Very extensive - Total - Undetermined	- Distal - Mesial - Proximal - Total	- Very-acute: $<30^{o}$ - Acute: 30^{o} - 60^{o} - Oblique: 60^{o} - 80^{o} - Steep: 80^{o} -100^{o} - Steep-inverse: $>100^{o}$

Table 3.4.5.1 Criteria for the analysis of the cores

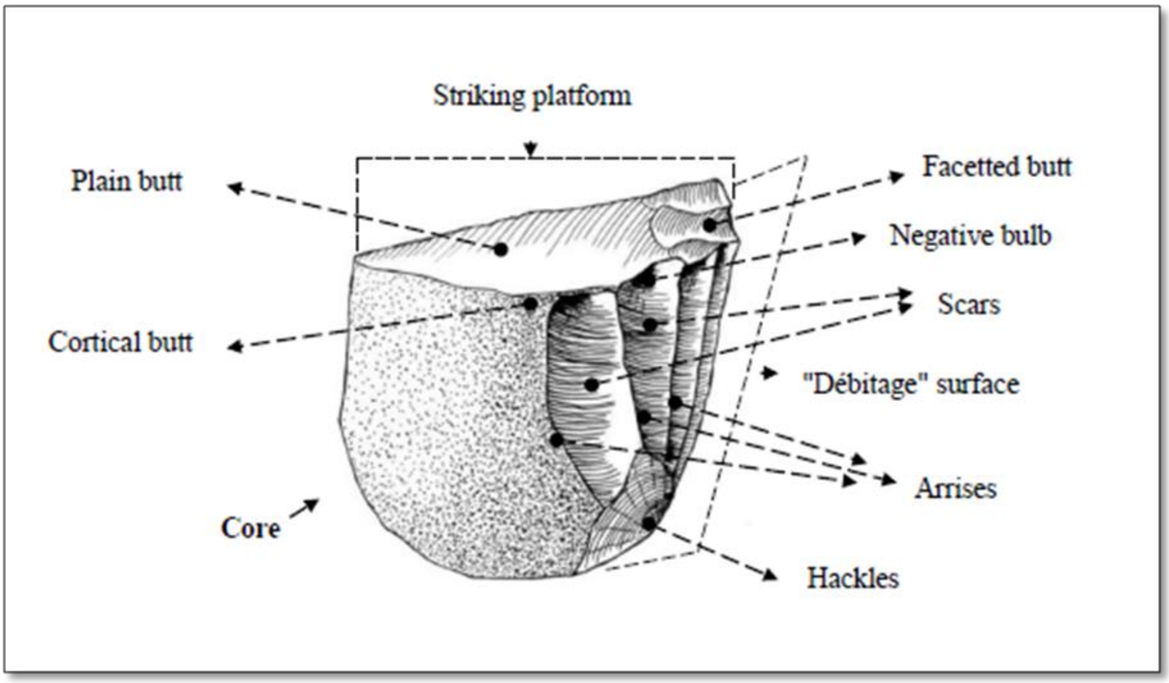


Figure 3.4.5.1 Main descriptive terms for cores (Modified from Inizan et al. 1999)

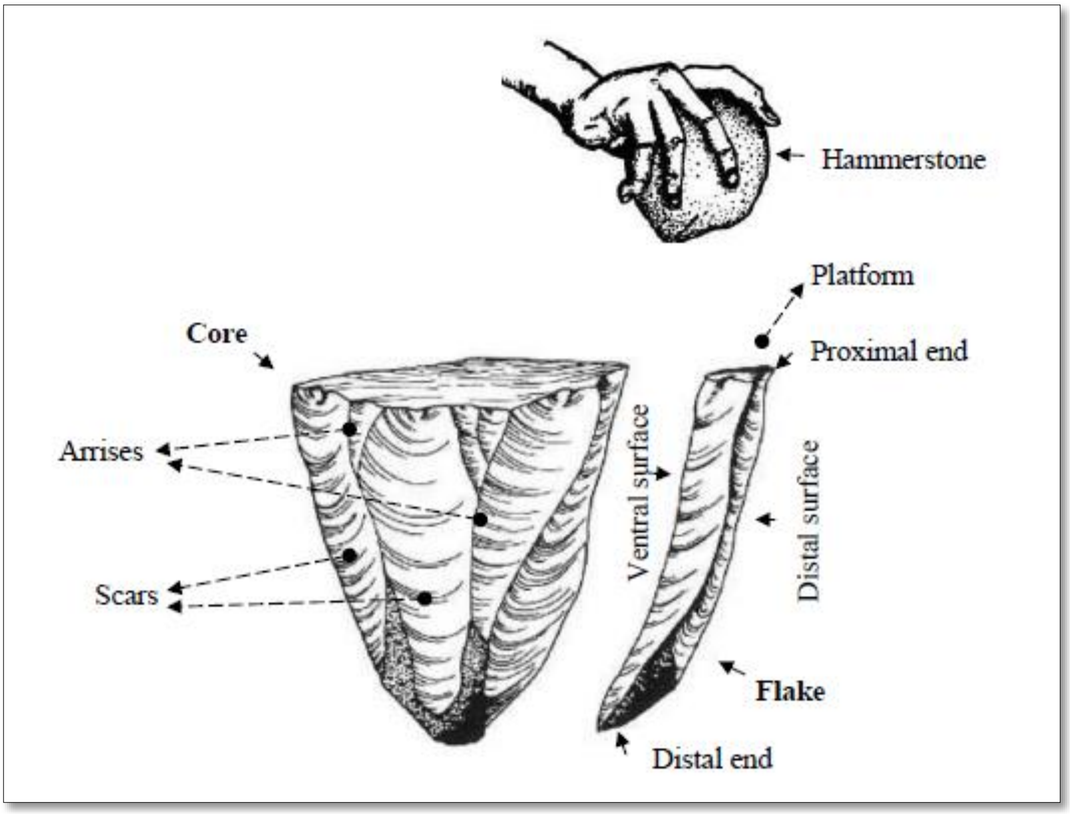


Figure 3.4.5.2 Main descriptive terms for cores (Modified from www.stoneagetools.co.uk)

***1) Dimensions of cores**: Measurement*

In order to measure them, the core are oriented. The method of orientation is the same as that of the tools. The length, width and thickness of each of the cores were taken using the Vernier Calliper.

Length: The length is the maximal dimension of the artefact, measured from proximal end to distal end, and defining the longitudinal axis.

Width: The width is the maximum measurement perpendicular to the length in the maximal dimension.

Thickness: The thickness is measured at the thickest place in perpendicular to the plane defined by the length and width.

Weight: in gram

2) General morphology

Number of faces	***Exploitation of the cores***	***General shape of contour***
- 2 faces - 3 faces - 4 faces - 5 faces - 6 faces	- Monofacial - Bifacial - Trifacial - Multifacial	- Almond - Quadrangular - Bi-convex - D-shape - Ellipse - Half -ellipse - Half- oval - Oval - Triangular - Trapezoidal - Pentagonal - Irregular

The general morphology of the cores is identified by the number of faces (from 2 faces to 6 faces for the cubic cores and even for the polyhedric cores whose shape may be simplified into a cube). All the faces may not be exploited (flaked) and therefore there are “Monofacial”, “Bifacial”, “Trifacial” or “Multifacial” cores. In addition the general contour is noted, like all tools general morphology **(figure 3.4.5.1)**. Then in the subsequent description all the shapes will be simplified into a volume having two faces (upper and lower faces).

3) Core reduction process: technical features of the faces

Amount of cortex	***Number of scars***	***Direction of scars***	***Extent of removals***	***Striking platform***
- Totally cortical - Cortical dominant *(>50% cortical)* - Non-cortical dominant *(<50% cortical)* - Non cortical	- 1 scar - 2 scars - 3 scars - 4 scars - 5 scars - 6 scars - > 6 scars	- Unipolar - Bipolar-opposite - Bidirectional-orthogonal - Three-directions - Convergent - Absent - Undetermined	- Marginal - Extensive - Very extensive - Total - Undetermined	- Cortex - Fracture - Removal - Undetermined

For each face several technical characters are observed. Usually the few cores from Tham Lod Rockshelter have only two faces. These are analysed in the same way as the shaped tools considering the amount of cortex, the number of scars within the range of 1 to 6, the direction and extent of removals (**figures 3.4.4.6, 3.4.4.7 and 3.4.4.8)**. The nature of the striking platforms is also examined.

4) Retouch

Direction of retouch	***Extent of retouch***	***Location of retouch***	***Angle of the edge with retouch***
- Direct - Inverse - Alternative - Alternating - Bifacial	- Marginal - Extensive - Very extensive - Total - Undetermined	- Distal - Mesial - Proximal - Total	- Very-acute: *<30º* - Acute: *30º - 60º* - Oblique: *60º - 80º* - Steep: *80º -100º* - Steep-inverse: *>100º*

Only a few cores are discovered in area 2 of Tham Lod Rockshelter and most of them have no retouch. Generally, the retouch on the cores is described in the same way as the tools, according to the “Direction” (**figure 3.4.4.12)**, “Extent” **(figure 3.4.4.6)**, “Position” **(figure 3.4.4.13)** and “Angle of the edge with retouch” (**figure 3.4.4.10)**.

ANALYSIS OF CORES																																			
SITE: Tham Lod Rockshelter, Pang Mapha (North-western Thailand)																																			
EXCAVATOR: Prof. Rasmi Shoocongdej																																			
COLLECTOR: Tham Lod Rockshelther / Area II sector S20W10																																			
DATE: TL´45																																			
No.	LEVEL	GRID	NUMBER	ARCHEOLOGICAL UNITE	RAW MATERIALS	TYPE OF ARTIFECTS	BLANK	MEASUREMENT				GENERAL MORPHOLOGY			UPPER FACE							LOWER FACE							RETOUCH OF CORE						
								Width	Breadth	Thickness	Weight	Number of Faces	General shap of contour	Exploitation of the core	Number of Scares	Amount of cortex	Direction of Scare	Extent fo removals	Striking platform			Number of Scares	Amount of cortex	Direction of Scare	Extent of removals	Striking platform			Extent of the retouch edge	Direction of retouch	Extent of removals	Location of retouch			
																			cort-	rem-	fract-					cort-	rem-	fract-				right	left	distal	proxi-
1	740-720	seq 3	10888	9	sandstor	core	cobble/	100	77	55	460	5	ptg	muti	5	nco-d	conv	ve	cort	rem	fract	1	co-d	unipi	m	cort	rem	fract							
1	640-600	seq 4	650	3	sandstor	core	cobble	107	110	56	500	4	irre	bipo-o	6	nco-d	bipo-o	ve	cort	rem	fract-	3	co-d	bipo-	ve	cort	rem								
1	640-620	seq 4	8361	3	sandstor	core	cobble/	142	102	83	1900	5	hxg	multi	10	co-d	conv	e	cort	rem	fract	4	co-d	bipo-	m	cort	rem	fract							

Table 3.4.5.2 Example of the chart used for analysis of cores

3.4.6 Criteria for Hammerstones Analysis

<table>
<tr><th colspan="12">Measurements</th></tr>
<tr><td colspan="3">- Length in mm</td><td colspan="3">- Width in mm</td><td colspan="3">- Thickness in mm</td><td colspan="3">- Weight in gram</td></tr>
<tr><th colspan="12">Blank of hammers</th></tr>
<tr><td colspan="6">Type of blank</td><td colspan="6">Type of fractures</td></tr>
<tr><td colspan="6">- Cobble / pebble
- Broken cobble / pebble</td><td colspan="6">- Oblique
- Perpendicular
- Split</td></tr>
<tr><th colspan="12">General morphology</th></tr>
<tr><td colspan="6">Dimensions</td><td colspan="6">Frontal view</td></tr>
<tr><td colspan="6">- Length
- Width
- Thickness</td><td colspan="6">- Almond
- Convex-concave
- D-shape
- Ellipse
- Half-ellipse
- Half-oval
- Irregular
- Oval
- Pentagonal
- Triangular
- Trapezoidal</td></tr>
<tr><th colspan="12">Hammering marks</th></tr>
<tr><td colspan="4">Type of hammering marks</td><td colspan="4">Intensity of Hammering marks</td><td colspan="4">Location of use marks</td></tr>
<tr><td colspan="4">- Pounding
- Chipping
- Both</td><td colspan="4">- High
- Medium
- Low</td><td colspan="4">- Right side
- Left side
- Distal side
- Proximal side
- Upper face
- Lower face</td></tr>
<tr><th colspan="12">Reddening / burning of hammers</th></tr>
<tr><td colspan="12">Burning marks on hammer</td></tr>
<tr><td colspan="12">- Entirely
- Cortex only
- Some parts of cortex</td></tr>
</table>

Table 3.4.6.1 Criteria for the analysis of hammerstones

1) Dimension of hammers: Measurement

The technical orientation of hammerstone is measured like other stone artefacts. The length, width, and thickness of hammerstones are taken and measured by Vernier Calliper.

2) Blank of hammers

Type of blank	***Type of fractures***
- Cobble/pebble - Broken cobble/pebble	- Oblique - Perpendicular - Split

The hammerstones are usually cobbles, sometimes pebbles (< 6 cm) well rounded by the river. They are sometimes broken, probably by use but without certainty. The description of the types of fracture may reveal some pattern **(figure 3.4.6.1 and 3.4.6.2)**.

3) General morphology

Frontal view
- Almond - Convex-concave - D-shape - Ellipse - Half-ellipse - Half-oval - Irregular - Oval - Pentagonal - Triangular - Trapezoidal

The general morphology of the hammerstone is studied according to the frontal view. Most of the shapes are identified like those of the other implements **(figure 3.4.3.6)**.

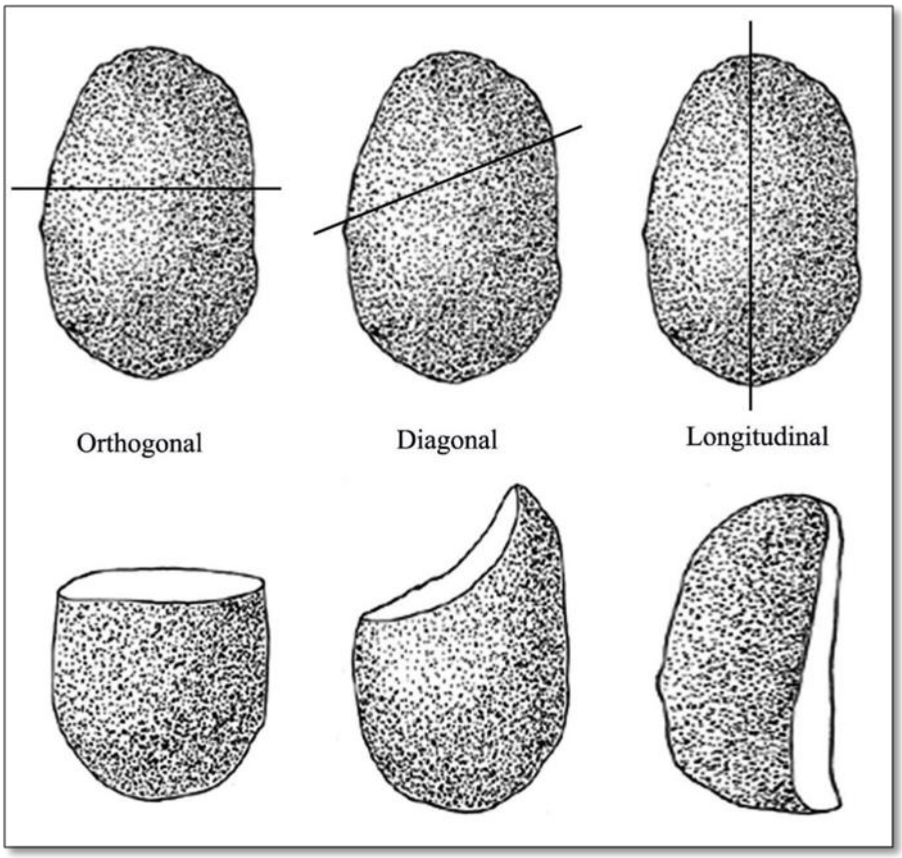


Figure 3.4.6.1 Illustration in frontal view of the main types of fractures that may affect the hammerstones

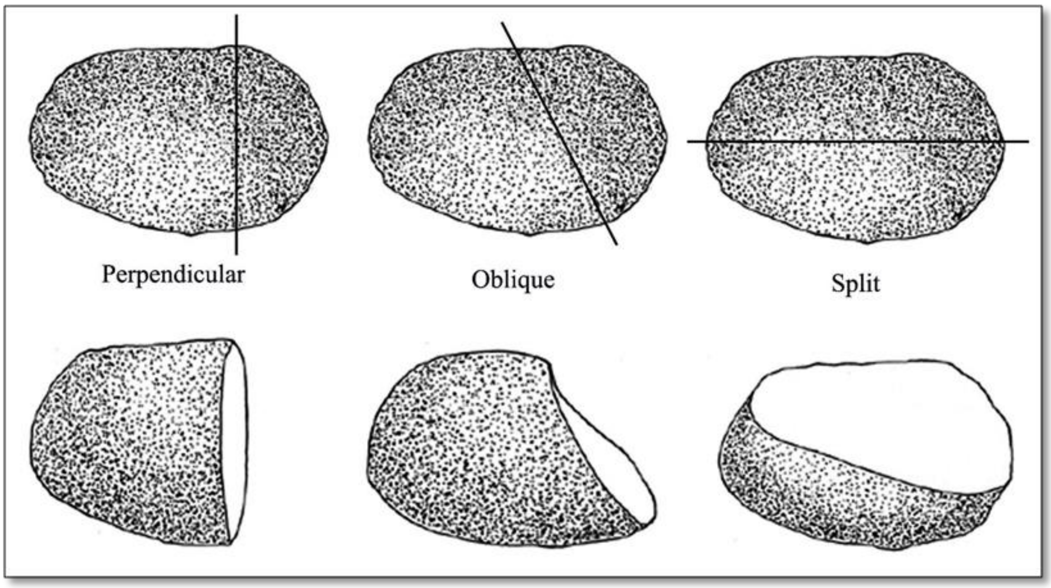


Figure 3.4.6.2 Illustration in sagittal view of the main types of fractures that may affect the hammerstones

4) Hammering marks

Type of hammering marks	*Intensity of hammering marks*	*Location of use marks*
- Pounding - Chipping - Both	- High - Medium - Low	- Right side - Left side - Distal side - Proximal side - Upper face - Lower face

Two types of hammering marks are distinguished: “Pounding”, “Chipping” (or both pounding and chipping). The intensity of hammering marks is also noted as well as their location **(figures 3.4.6.3 & 3.4.6.4)**.

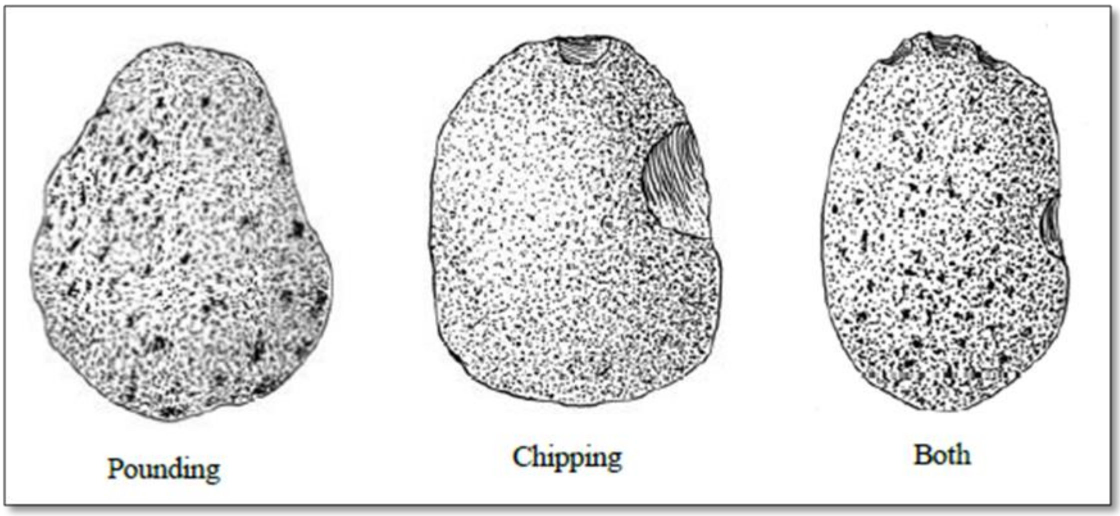


Figure 3.4.6.3 Illustration of the types of hammering marks

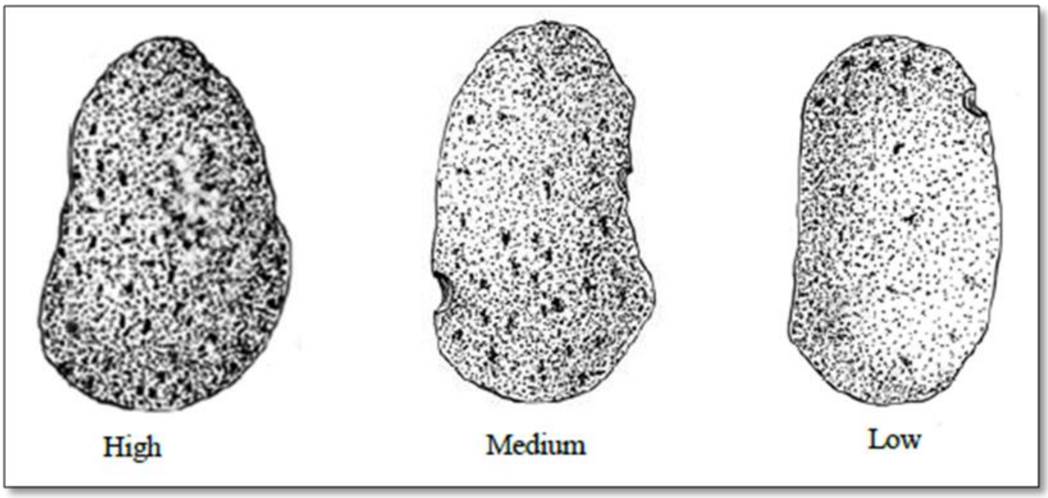


Figure 3.4.6.4 Illustration of the intensity of hammering marks

5) Reddening / burning of hammers

Burning marks on hammer
- Entirely - Cortex only - Some parts of cortex

Many artefacts from Tham Lod Rockshelter show reddening on their surface, either on their entire surface, on cortex only or some part of cortex. This is especially visible on hammerstones. This colour is probably due to burning as among the archaeological remains the majority of the bones are also burnt and some fire places have been identified during the excavation.

ANALYSIS HAMMER TOOLS (Retoucher)																						
SITE: Tham Lod Rockshelther, Pang Mapha (North-western Thailand)																						
EXCAVATOR: Prof. Rasmi Shoocongdej																						
COLLECTOR: Tham Lod Rockshelter / Area II (S20W10)																						
DATE: TL´45																						
No.	LEVEL	GRID	NUMBER	STRATIGRAPHIC LAYER	RAW MATERIALS	TYPE OF ARTEFACT	TYPE OF FRACTURE	MEASUREMENTS				GENERAL MORPHOLOGY	HAMMERRING MARKS		LOCATION OF DAMAGE						REDENNING	REMARKS
								Lenght	Breadth	Thickess	Weight (g)	Frontqal view	Type of hammerring marks	Intensity of Hammarring marks	Right side	Left side	Distal side	Proximal side	Upper face	Lower face	Burning	
1	780-760	seq 4	11191	10	sandstone	hammer/E	ob	145	90	82	1350	ov	picking	medium				x				
2	780-760	seq 4	11185	10	sandstone	hammer/E	per	79	130	37	549	d-shap	both	medium		x		x				
3	780-760	seq 4	1	10	sandstone	hammer/E	per	62	80	42	250	trg	picking	medium		x	x					
4	780-760	seq 4	3	10	sandstone	hammer		120	84	53	710	almond	picking	high	x	x	x	x				
5	780-760	seq 4	5	10	sandstone	hammer		101	83	53	475	irre	both	low		x	x					

Table 3.4.6.2 Example of the chart used for analysis of hammerstones

3.4.7 Criteria for Big fragments Analysis

<table>
<tr><th colspan="4">Measurements</th></tr>
<tr><td>- Length in mm</td><td>- Width in mm</td><td>- Thickness in mm</td><td>- Weight in gram</td></tr>
<tr><th colspan="4">General morphology</th></tr>
<tr><td colspan="2">Dimensions</td><td colspan="2">Frontal view</td></tr>
<tr><td colspan="2">- Length
- Width
- Thickness</td><td colspan="2">- Almond
- Convex-concave
- D-shape
- Ellipse
- Half-ellipse
- Half-oval
- Irregular
- Oval
- Pentagonal
- Triangular
- Trapezoidal</td></tr>
<tr><th colspan="4">Fractures</th></tr>
<tr><td colspan="2">Type of fractures</td><td colspan="2">Location of fractures</td></tr>
<tr><td colspan="2">- Oblique
- Perpendicular
- Split</td><td colspan="2">- Right side
- Left side
- Distal site
- Proximal side
- Upper face
- Lower face</td></tr>
<tr><th colspan="4">Damage on the edges</th></tr>
<tr><td colspan="2">Pounding of the edges</td><td colspan="2">Chipping of the edges</td></tr>
<tr><td colspan="2">- Right side
- Left side
- Distal side
- Proximal side</td><td colspan="2">- Right side
- Left side
- Distal side
- Proximal side</td></tr>
<tr><th colspan="4">Reddening: Burning of big fragments</th></tr>
<tr><td colspan="4">Burning marks on big fragments</td></tr>
<tr><td colspan="4">- Entirely
- Cortex only
- Some parts of cortex</td></tr>
</table>

Table 3.4.7.1 Criteria for the analysis of big fragments

1) Dimension big fragments: Measurement

The big fragments are measured like other stone artefacts. Their longitudinal axis corresponds to their maximal dimension (length): this is a morphological orientation as they do not have any technical feature allowing a technical orientation, unlike the flakes.

2) General morphology

The general morphology of the big fragments is studied according to the frontal view. Most of their shapes are identified like other stone artefacts **(figure 3.4.3.6)**.

3) Type of fractures

The type of fracture is determined as for the hammerstones: “Oblique”, “Perpendicular” or “Split” **(Figure 3.4.6.2)**, especially in sagittal view in order to assess the acuteness of the edges.

4) Location of fractures

The fragments usually bear several fractures. These are noted as present or absent at each of the four edges of the artefact.

5) Damage of the edges

As for the other artefacts, damage occurring on each of the edges is recorded as either “Pounding” or “Chipping”.

6) Reddening / burning of big fragments

The burning marks on the big fragments are similarly remarked as on the other stone artefacts.

ANALYSIS BIG FRAGMENTS
SITE: Tham Lod Rockshelther, Pang Mapha (North-western Thailand)
EXCAVATOR: Prof. Rasmi Shoocongdej
COLLECTOR: Tham Lod Rockshelter / Area II (S20W10)
DATE: TL´45

No.	LEVEL	GRID	NUMBER	STRATIGRAPHIC LAYER	RAW MATERIAL	TYPE OF ARETEFACT	TYPE OF FRACTURE	MEASUREMENTS				GENERAL MORPHOLOGY	LOCATION OF FRACTURE				DAMAGE OF THE EDGE				REDENNING	REMARKS	UNCOUNTED FRAGMENTS		
								Lenght	Breadth	Thickess	Weight (g)	Frontal view	Right	Left	distal	Proximal	Right side	Left side	Distal side	Proximal side	Burning		Raw materials	Blank	Number of artefacts
1	540-500	seq 3		2	sandstone	cobble/B	per	100	63	38	320	trp	x	x	x	x									
2	540-500	seq 3		2	sandstone	cobble/B	per	101	45	28	130	irre	x	x	x	x									
3	540-520	seq 4		2	sandstone	cobble/B	per	103	65	55	580	trp		x	x										
4	540-520	seq 4		2	sandstone	cobble/B	per	104	75	51	475	trp	x	x	x	x									
5	540-520	seq 4	3772	2	sandstone	cobble/B	per	104	46	39	225	irre	x	x						picking					
6	540-500	seq 3		2	sandstone	cobble/B	ob	105	59	25	180	oval			x										
7	500-490	seq 4	1205	2	sandstone	cobble/B	per	105	61	27	270	irre	x			x		picking	picking	chipping					
8	500-480	seq 3		2	sandstone	cobble/B	per	105	60	33	345	trp	x		x			chipping		picking					
9	500-490	seq 4	4100	2	sandstone	cobble/B	per	106	79	65	625	trg	x	x	x	x									
10	500-480	seq 3		2	sandstone	cobble/B	per	106	85	52	530	irre	x	x		x									

Table 3.4.7.2 Example of the chart used for analysis of big fragments

3.3.8 Criteria for Small fragments Analysis

1) Flake fragments

Flake fragments are any identified flakes that lost their distal part (*i.e.* only proximal part is observable). The distal parts of the broken flakes are difficult to identify as flake fragment because they do not show any technical feature. Therefore, they are counted along with the fragments.

2) Small fragments

Fragments are broken pieces of imported rock. Among them there are probably broken flakes, but impossible to identify. Some of the fragments show concave fractures suggesting they have been produced by heat stroke. Given the number of burnt items, especially bones, in Tham Lod Rockshelter, it is quite possible that pieces of sandstone were also burnt. The question is whether they were intentionally put into fire or not. Their very high number did not allow a detailed analysis in the context of the present study, but they may deserve it. They have just been sorted according to their raw material and counted.

Only various sizes of small fragments have allowed to determine the number of artefacts. Generally, they are largely more explored than other stone assemblage. Most of them are made from grey sandstone.

ANALYSIS SMALL FRAGMENT							
SITE: Tham Lod Rockshelther, Pang Mapha (North-western Thailand)							
EXCAVATOR: Prof. Rasmi Shoocongdej							
COLLECTOR: Tham Lod Rockshelter / Area II (S20W10)							
DATE: TL´45							
No.	LEVEL	GRID	STRATIGRAPHIC LAYER	RAW MATERIALS	BLANK	NUMBER OF ARTIFACTS	REMARKS
1	780-760	seq 4	10	sandstone	small fragments	21	
2	780-760	seq 4	10	sandstone	flake fragments	8	
3	780-760	seq 3	10	sandstone	small fragments	30	
4	780-760	seq 3	10	black sandstone	small fragment	1	
5	780-760	seq 3	10	sandstone	flake fragment	1	
6	760-740	seq 3	10	sandstone	small fragments	168	
7	760-740	seq 3	10	quartz	small fragment	1	
8	760-740	seq 3	10	black sandstone	small fragments	14	
9	760-740	seq 3	10	black sandstone	flake fragments	9	
10	760-740	seq 3	10	mudstone	small fragments	2	
11	760-740	seq 3	10	siliceous shale	flake fragments	8	
12	760-740	seq 3	10	quartzite	small fragment	1	
13	760-740	seq 3	10	mudstone	small fragments	13	
14	760-740	seq 3	10	sandstone	small fragments	55	

Table 3.4.8.1 Example of the chart used for analysis of flake fragments & small fragments

3.4.9 Criteria for Unmodified manuports (pebbles & cobbles) Analysis

Measurements			
- Length in mm	- Width in mm	- Thickness in mm	- Weight in gram
Type of unmodified manuports			
Type of blank		***Type of fractures***	
- Boulder - Cobble - Broken cobble - Pebble - Broken pebble		- Oblique - Perpendicular - Split	
General morphology			
Dimensions		***Frontal view***	
- Length - Width - Thickness		- Almond - Convex-concave - D-shape - Ellipse - Half-ellipse - Half-oval - Irregular - Oval - Pentagonal - Triangular - Trapezoidal	
Location of fractures			
Location of fractures			
- Right side - Left side - Distal site - Proximal side - Upper face - Lower face			
Reddening: Burning of unmodified manuports			
Burning marks on unmodified manuports			
- Entirely - Cortex only - Some parts of cortex			

Table 3.4.9.1 Criteria for the analysis of unmodified manuports (cobbles & pebbles)

The unmodified manuports are studied in the same way as the hammerstones. Only the hammering marks are absent, or not visible.

ANALYSIS UNMODIFIED MANUPORTS (PEBBLES/ COBBLES)																		
SITE: Tham Lod Rockshelther, Pang Mapha (North-western Thailand)																		
EXCAVATOR: Prof. Rasmi Shoocongdej																		
COLLECTOR: Tham Lod Rockshelter / Area II (S20W10)																		
DATE: TL´45																		
No.	LEVEL	GRID	NUMBER	STRATIGRAPHIC LAYER	RAW MATERIALS	BLANK	TYPE OF FRACTURE	MEASUREMENTS				GENERAL MORPHOLOGY	LOCATION OF FRACTURE				REDENNING	REMARKS
								Lenght	Breadth	Thickess	Weight (g)	Frontal view					Burning	
													Right	Left	Distal	Proximal		
1	780-760	seq 4	2	10	sandstone	pebble		81	50	23	140	oval			x			
2	780-760	seq 4	4	10	sandstone	cobble		111	86	51	590	oval						
3	780-760	seq 4	7	10	sandstone	cobble/B	per	112	86	61	700	oval		x				
4	780-760	seq 3	9	10	sandstone	cobble		73	57	35	150	oval						
5	780-760	seq 3	10	10	sandstone	cobble/B	ob	85	55	38	145	almond		x				
6	780-760	seq 3	11	10	sandstone	pebble		66	64	27	140	cir						

Table 3.3.9.2 Example of the chart used for analysis of unmodified manuports (pebbles& cobbles)

CHAPTER IV

Analysis of the Lithic Materials from Tham Lod Rockshelter Area 2 sectors S20W10 (SEQ 3-4) and S21W10 (SEQ 3-4 & 1-2)

4.1 Scope and limit study

The main subject of this research- the lithic industry from Tham Lod rockshelter, area 2 sectors S20W10 (SEQ 3-4) and S21W10 (SEQ 3-4 & SEQ 1-2), was presented in the report of excavation at Tham Lod rockshelter in 2004, 2005 and 2007 (Shoocongdej 2004, 2005, 2007; Kheawtaya 2005). In the previous studies the lithic assemblage had only been divided into flakes and cores. The flakes had been identified as primary, secondary and tertiary, and classified into three groups like utilized flakes, reshaping flakes and waste flakes. As for the cores, they had been determined as utilized cores, broken cores and waste cores. However, all the stone materials were recorded in the field notes and forms of the excavation layers (Shoocongdej 2003, 2004, 2005, 2007). Some lithic artefacts from area 3 had been analyzed in a master's dissertation (Khaokhiew 2004). Another work had been done on the human behavioral ecology in northwestern Thailand during the terminal Pleistocene and Holocene; technology was elaborately studied under the experimental viewpoint by Marwick (2008).

No lithic analysis has ever been done by morpho-technical method at Tham Lod rockshelter. This research is a new interpretation of stone artefacts to understand the human behavior pattern in North-western Thailand, especially for Tham Lod valley. Therefore, lithic materials had been classified into seven type categories like blank flakes, all tools (heavy-duty tools and light- duty tools), cores, hammerstones, unmodified manuports (pebbles& cobbles), big fragments and small fragments.

A total of 12,860 stone artefacts were classified in this research. Out of these, there were 7571 specimens from sector S20W10 (SEQ 3-4) and 4276 specimens from sector S21W10 (SEQ 3-4). As a complement, from the sector S21W10 (SEQ 1-2), had only been selected the large tools and small tools from the layers that are missing in the former sector (layers 5, 6 and 7). Only 42 large tools and 69 small tools were analyzed. Other materials (902 artefacts) had been recorded by classified numbers in different categories. About studying the sequence of lithic materials, until now, there is no detailed analysis of the technology, morphology and typology of stone artefacts from Tham Lod rockshelter.

This study will help in establishing the technical evolutionary trends in north-western Thailand and the relationship between the technical practice in use during the late Pleistocene in this region and other parts of Thailand and Southeast Asia.

4.2 Distribution of different categories of lithic artefacts from area 2 sectors S20W10 (SEQ 3-4) and S21W10 (SEQ 3-4, SEQ 1-2)

All together, the studied lithic artefacts amount to 11,753 items, representing material from stratigraphic layers 3 to 10 of area 2 sectors S20W10 (SEQ 3-4) and S21W10 (SEQ 3-4, SEQ 1-2). Generally, the natural stratigraphy from these sectors is composed of 10 layers, but the first layer was occupied in the late Holocene period and will not be considered here. According to Shoocongdej R., in the layer 2, several archaeological remains from late Holocene, besides recent materials, are combined with the early Holocene assemblage. Hence, to avoid the problem of mixture between lithic assemblages, I will confine my study to the Pleistocene layers 3 to 10. The main categories of artefacts are the flakes (1377=13%), large tools / heavy-duty tools (393 =3%), small tools / light-duty tools (411= 4%), hammerstones (745=7%), unmodified manuports (pebbles & cobbles) (276=3%), big fragments (319=3%) and small fragments (7222=67%) **(Table 4.2.1, figure 4.2.3)**.

The stone artefacts are more numerous in the upper layers. The layer 3 is by far the richest in the series, with nearly 35%, followed by the layer 4 (2266: 21%). In the other layers, the artefacts are much less in these sectors, especially the layer 6 (232/10740: 2%), poor in all the categories **(Table 4.2.1)**. Regarding the raw materials, numerous artefacts are in gray sandstone (more than 90%) in all the layers, besides a few ones in black sandstone, quartzite, siliceous shale and quartz, etc.

The principal category of lithic artefacts consists of fragments, especially of small fragments, with nearly 70% of the studied material. In the middle layers, they are overwhelming, highly present in the layer 7, with about 83%. The lowest proportion is in the layer 4 (56%). In the other layers, they are somewhat constant in number, frequently graded between 60-77%. On the other hand, the big fragments are somewhat rare, and even nil in the middle layers (5 to 7).

The flakes are totalising 1377 (13% of the studied material). The layer 4 is by far the richest in numbers, providing 430 items, and followed by layer 3 (345 items). The lowest number is in the layer 6 (only 9 items) in the series. Most of the percentages are not representative in the proportion, except in the layer 5, where it is around 22% (151/689).

The ratio of proper tools (heavy-duty tools and light-duty tools) is identical with that of hammerstones, providing 7%. The most significant numbers are in the upper layers (3 to 4), especially in the layer 3 (small tools: 128 and large tools: 138) but all of the tools are hardly represented in proportionality, with the exception of the layer 6, where they reach around 19% (45/232 including small tool: 31/232 and large tools: 14/232).

It is interesting to note that almost no cores have been recovered in these sectors **(Table 4.2.1)**.

Lithic categories **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Blank flakes**		**Light-duty tools**		**Heavy-duty tools**		**Cores**		**Hammerstones**		**Big fragments**		**Small fragments**		**Unmodified manuports**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**345**	10	**128**	3	**138**	4	**2**		**341**	9	**184**	5	**2409**	67	**64**	2	**3611**
Layer 4 (340-700 cm dt.)	**430**	19	**121**	5	**79**	4	**1**		**231**	10	**85**	4	**1271**	56	**48**	2	**2266**
Layer 5 (400-470 cm dt.)	**151**	22	**14**	2	**7**	1	**0**		**5**	1	**0**		**501**	73	**11**	1	**689**
Layer 6 (470- 520 cm dt.)	**9**	4	**31**	13	**14**	6	**0**		**2**		**0**		**165**	71	**11**	5	**232**
Layer 7 (520- 580 cm dt.)	**89**	7	**28**	2	**38**	3	**2**		**9**	1	**0**		**1043**	83	**49**	4	**1258**
Layer 8 (580-720 cm dt.)	**179**	13	**43**	3	**60**	5	**0**		**73**	5	**25**	2	**961**	70	**30**	2	**1371**
Layer 9 (620-740 cm dt.)	**147**	19	**39**	5	**36**	5	**2**		**41**	5	**11**	1	**475**	60	**38**	5	**789**
Layer 10 (700-780 cm dt.)	**27**	5	**7**	1	**11**	2	**0**		**43**	8	**14**	3	**397**	76	**25**	5	**524**
Total	**1377**	13	**411**	4	**383**	3	**7**	0	**745**	7	**319**	3	**7222**	67	**276**	3	**10740**

Table 4.2.1 Distribution of the main categories of lithic artefacts in the stratigraphic sequence of sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4), area 2 of Tham Lod Rockshelter

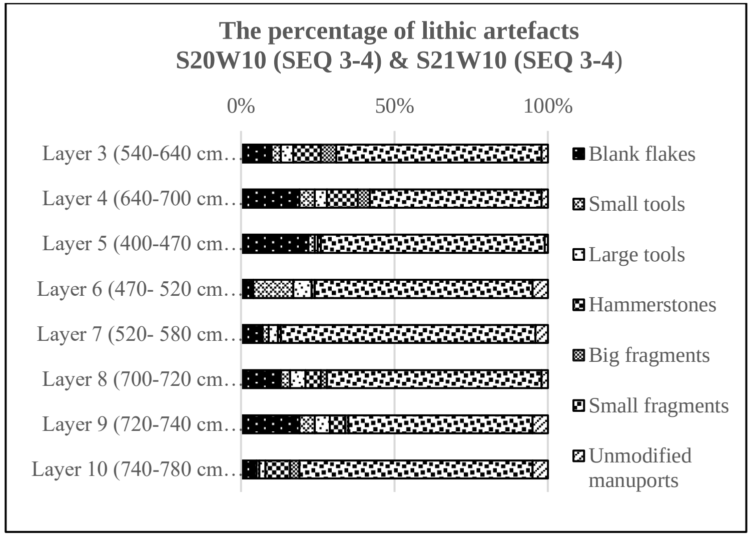


Figure 4.2.1 Distribution of the main categories of lithic artefacts in the stratigraphic sequence of area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

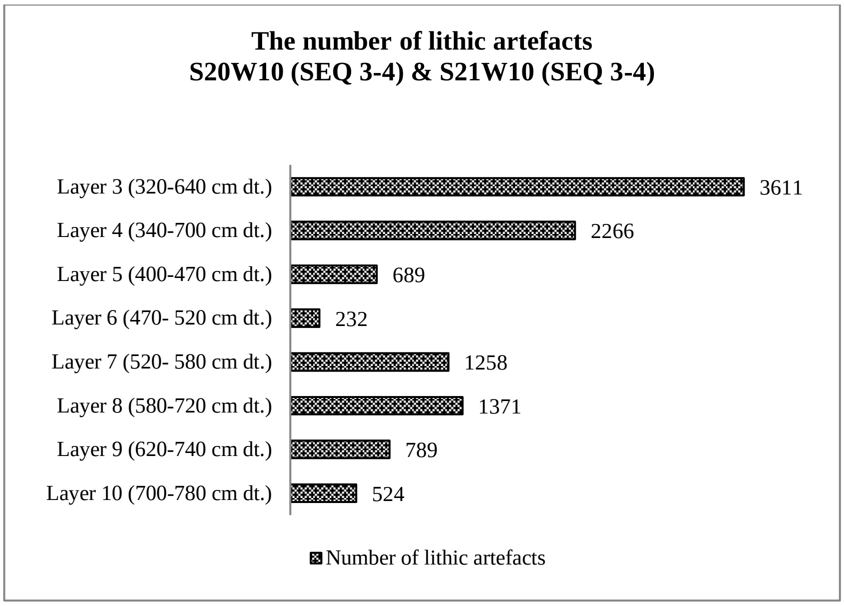


Figure 4.2.2 Distribution of the total number of lithic artefacts in the stratigraphic sequence of area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

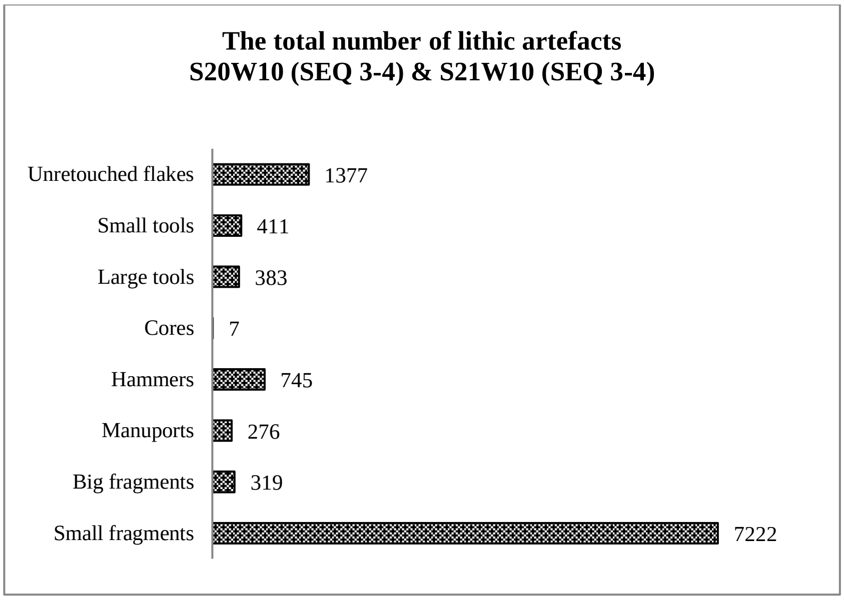


Figure 4.2.3 Distribution (in numbers) of the main categories of lithic artefacts from Tham Lod rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

All tools (large & small) **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Choppers**		**Sumatra-liths**		**Partial sumatra-liths**		**Scrapers**		**Atypical small tools**		**Denti-culates**		**Pointed tools**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**86**	32	**37**	14	**57**	21	**53**	20	**13**	5	**15**	6	**5**	2	**266**
Layer 4 (340-700 cm dt.)	**33**	16	**41**	20	**34**	17	**56**	28	**13**	7	**12**	6	**11**	6	**200**
Layer 5 (400-470 cm dt.)	**5**	24	**4**		**3**		**7**	33	**2**		**0**		**0**		**21**
Layer 6 (470-520 cm dt.)	**10**	22	**10**	22	**13**	29	**8**	18	**3**		**0**		**1**		**45**
Layer 7 (520-580 cm dt.)	**31**	47	**6**	9	**7**	11	**18**	27	**2**		**1**		**1**		**66**
Layer 8 (580-720 cm dt.)	**49**	47	**11**	11	**7**	7	**23**	22	**10**	10	**2**		**1**		**103**
Layer 9 (620-740 cm dt.)	**29**	39	**8**	11	**10**	13	**19**	25	**4**		**3**		**2**		**75**
Layer 10 (700-780 cm dt.)	**11**	61	**0**		**0**		**4**		**0**		**1**		**2**		**18**
Total	**254**	32	**117**	15	**131**	16	**188**	24	**47**	6	**34**	4	**23**	3	**794**

Table 4.2.2 Distribution of the tools (large and small tools) across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

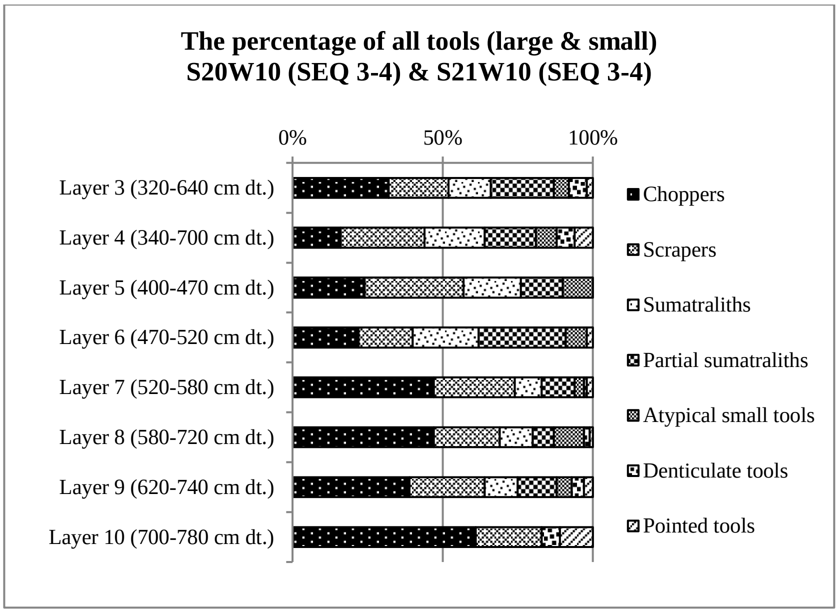


Figure 4.2.4 Distribution (percentage) of tools (large and small tools) across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4.3 Analysis of blank flakes from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

1) General features of the blank flakes

A total of 1377 (13% of the studied material) flakes is analysed from layers 3 to 10 of area 2 sectors S20W10 and S21W10. Flakes are rather preponderant in the upper layers. The highest number is in the layer 4 (430 items), followed by the layer 3 (345 items). Similar numbers can be seen in the middle and lower layers 5, 8 and 9, with around 150-178 items. In the other layers, they are less than 100 items. The lowest number is in the layer 6, with only 9 items **(Table 4.3.1)**. By contrast, the percentage of flakes is highly remarkable in the layer 5 (151/689: 22%), afterwards in the layers 4 (430/2266) and 9 (147/789), at nearly 20%.

Blank flakes	**Layer 2**		**Layer 3**		**Layer 4**		**Layer 5**		**Layer 6**		**Layer 7**		**Layer 8**		**Layer 9**		**Layer 10**		**Total**
Numbers (%)	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
S20W10 (SEQ 3-4)	**83**	11	**260**	8	**411**	22	**0**		**0**		**0**		**139**	14	**84**	25	**27**	5	**1004**
S21W10 (SEQ 3-4)	**64**	17	**85**	19	**19**	5	**151**	22	**9**	4	**89**	7	**40**	10	**63**	14	**0**		
S21W10 (SEQ 1-2)	**-**		**-**		**-**		**44**	14	**241**	38	**13**	19	**-**		**-**		**-**		**42**
S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**147**		**345**	10	**430**	19	**151**	22	**9**	4	**89**	7	**179**	13	**147**	19	**27**	5	**1377**(13%)
Lithic Artefacts S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)			**3611**		**2266**		**689**		**232**		**1258**		**1371**		**789**		**524**		**10740**

Table 4.3.1 Total number of flakes in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4), S21W10 (SEQ 3-4) and S21W10 (SEQ 3-4)

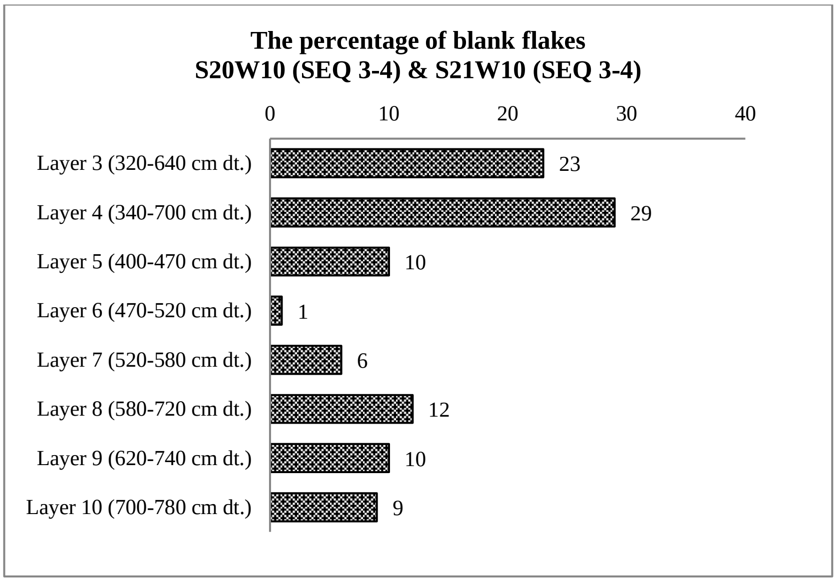


Figure 4.3.1 Distribution of the percentage of flakes in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Raw materials **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Gray sandstone**		**Black sandstone**		**Quartz**		**Siliceous shale**		**Quartzite**		**Mudstone**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**333**	96	**4**		**0**		**6**	2	**2**		**0**		**345**
Layer 4 (340-700 cm dt.)	**401**	93	**7**	1	**0**		**16**	4	**3**		**3**		**430**
Layer 5 (400-470 cm dt.)	**146**	97	**4**		**1**		**0**		**0**		**0**		**151**
Layer 6 (470-520 cm dt.)	**9**	100	**0**		**0**		**0**		**0**		**0**		**9**
Layer 7 (520-580 cm dt.)	**85**	96	**4**		**0**		**0**		**0**		**0**		**89**
Layer 8 (580-720 cm dt.)	**147**	82	**10**	6	**0**		**7**	4	**13**	7	**2**		**179**
Layer 9 (620-740 cm dt.)	**122**	83	**15**	10	**1**		**0**		**7**	5	**2**		**147**
Layer 10 (700-780 cm dt.)	**20**	74	**6**	22	**0**		**0**		**1**		**0**		**127**
Total	**1263**	92	**50**	4	**2**		**29**	2	**26**	2	**7**	0	**1377**

Table 4.3.2 The raw materials of flakes from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Several types of raw materials were identified among the flakes: gray sandstone, black sandstone, quartzite, mudstone, siliceous shale and quartz **(Table 4.3.2)**. The large majority of the flakes are in gray sandstone (1263: 92% of the flakes). The highest number is in the layer 4 (401 pieces), afterwards in the layer 3 (333 pieces). The smallest ones are in the layers 6 and 10, with around 9-20 specimens. The most significant percentage is in the upper and middle layers (3 to 7), with more than 93%. The maximal value is in the layer 6 and the minima are in the lower layers (8 to 10), mainly in the bottom (layer 10: 74%). Correlatively, the other raw materials are barely represented except in the lower layers (8 to 10), where they are well evident of black sandstone and quartzite.

2) Measurements

Measurement **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Length (mm)**	**Width (mm)**	**Thickness (mm)**	**Number of flakes**
Layer 3 (320-640 cm dt.)	39	39	10	345
Layer 4 (340-700 cm dt.)	42	39	13	430
Layer 5 (400-470 cm dt.)	36	32	9	151
Layer 6 (470-520 cm dt.)	45	45	13	9
Layer 7 (520-580 cm dt.)	43	41	12	89
Layer 8 (580-720 cm dt.)	40	39	12	179
Layer 9 (620-740 cm dt.)	42	38	12	147
Layer 10 (700-780 cm dt.)	47	45	16	127
Average	**42**	**40**	**12**	**1377**

Table 4.3.3 Average dimensions of the flakes from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ3-4)

The average length and width of the flakes is somewhat constant throughout the stratigraphy, varying between 36 and 47 mm for the length and between 32 and 45 mm for the width. The longest flakes are in the bottom (layer 10: 47 mm) and the shortest are in the middle layer (5: 36 mm). The widest flakes are in the layers 6 and 10 (45 mm) and the narrowest in the layer 5 (32 mm). Besides, the average thickness is 12 mm and it is quite constant in all the layers, with the exception of the layer 10, where it is around 16 mm. Flakes are globally bigger in the layer 10 and smaller in the layer 5. In addition, the longest flake is 164 mm and widest is 244 mm. The shortest flake is 8 mm and the narrowest one is 7 mm **(Table 4.3.3, figures 4.3.5 & 4.3.6)**.

It is interesting to note that among the blank flakes, the large flakes (>10 cm) are almost absent.

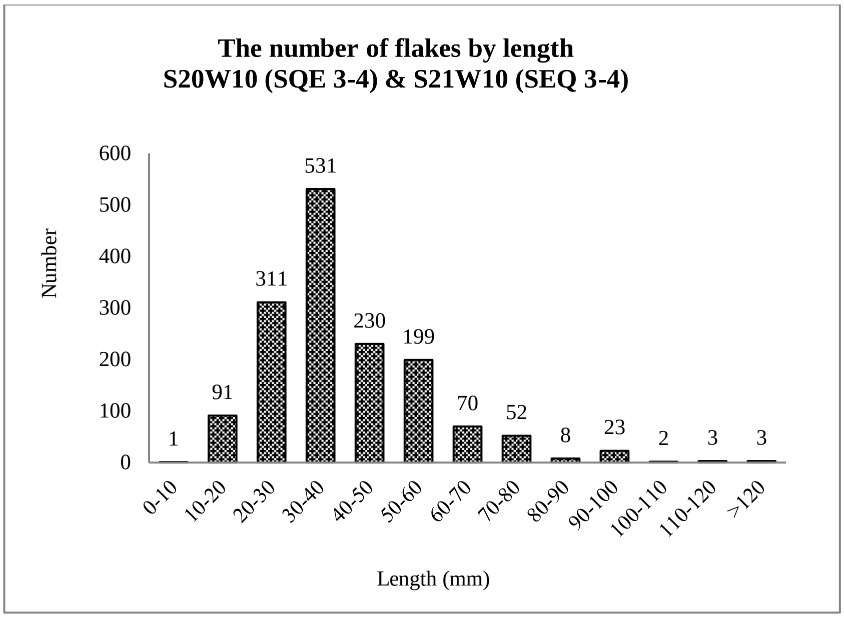


Figure 4.3.2 Distribution of the flakes by length from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

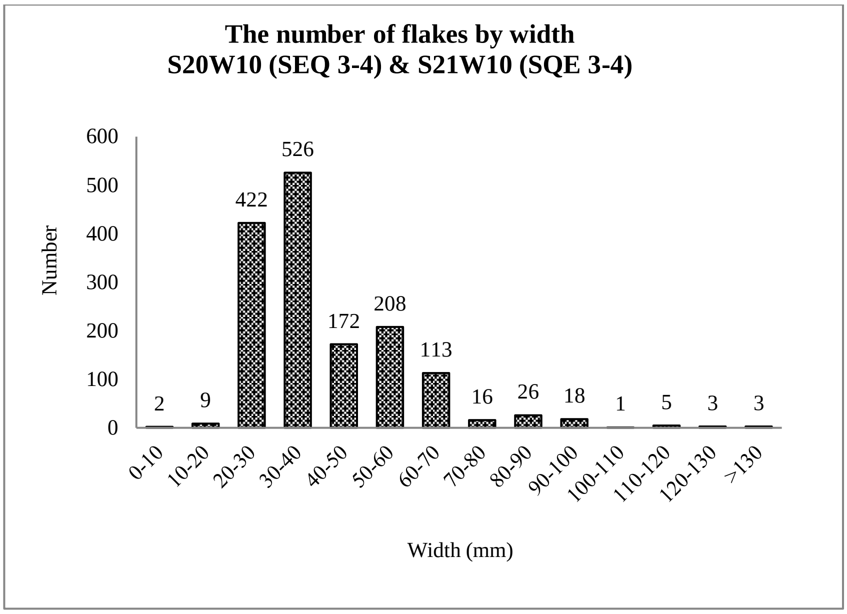


Figure 4.3.3 Distribution of the flakes by width from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

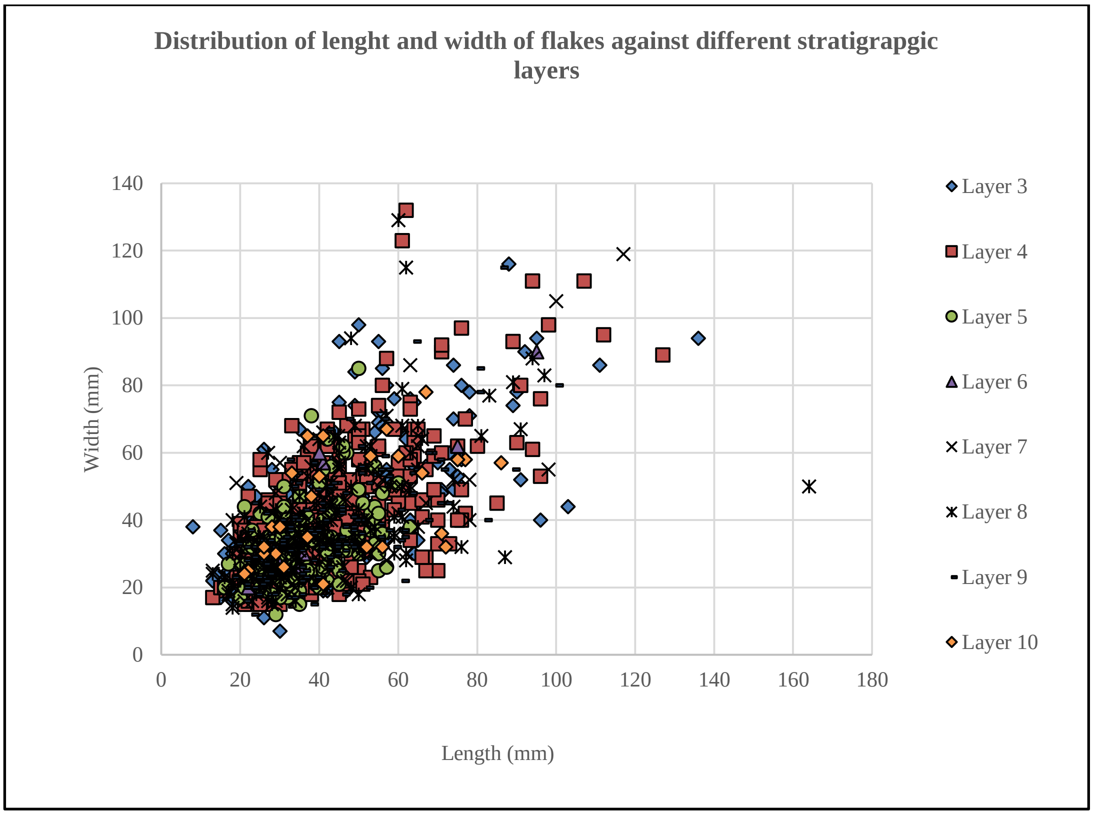


Figure 4.3.4 Scatter diagram length x width of the flakes from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

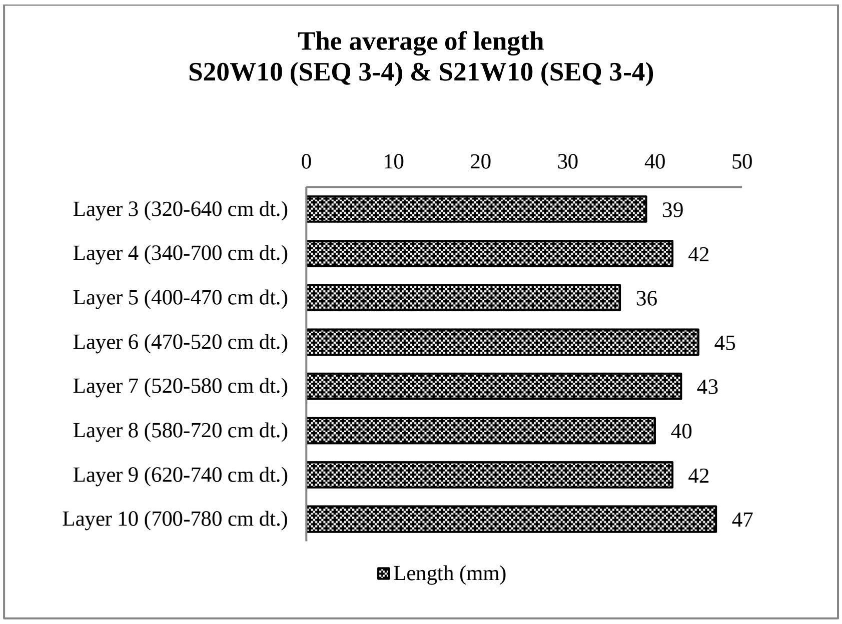


Figure 4.3.5 Distribution of the average length of the flakes across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

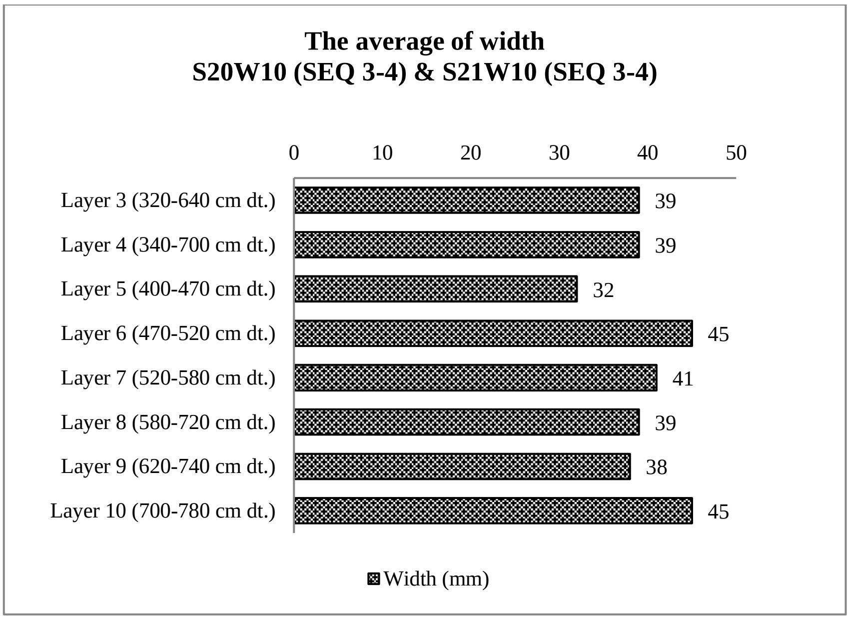


Figure 4.3.6 Distribution of the average width of the flakes across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

3) Ventral face of blank flakes

3.1) Type of bulb

Type of bulb S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	Marked		Diffuse		Total
Stratigraphic layers	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**25**	7	**320**	93	**345**
Layer 4 (340-700 cm dt.)	**77**	18	**353**	82	**430**
Layer 5 (400-470 cm dt.)	**21**	14	**130**	86	**151**
Layer 6 (470-520 cm dt.)	**1**		**8**	89	**9**
Layer 7 (520-580 cm dt.)	**24**	27	**65**	73	**89**
Layer 8 (580-720 cm dt.)	**29**	16	**150**	84	**179**
Layer 9 (620-740 cm dt.)	**20**	14	**127**	86	**147**
Layer 10 (700-780 cm dt.)	**8**	30	**19**	70	**27**
Total	**205**	13	**1172**	87	**1377**

Table 4.3.4 The type of bulb on ventral face of flakes across the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The flakes have a diffuse bulb (1172: 87%) rather than a marked bulb (205: 13%) on their ventral face. The diffuse bulbs are especially frequent in the upper layer 3 (93%). While the marked bulbs have a maximal frequency in the bottom layer 10 (8/27: 30%), followed by the layer 7 (24/89: 27%). In the other layers, the marked bulbs represent around 15% **(Table 4.3.4)**

4) Butt of blank flakes

4.1) Corticality of butt

Corticality of butt S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	Totally cortical		Cortical dominant (>50% cortical)		Non-cortical dominant (<50% cortical)		Non cortical		Total
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**240**	70	**35**	10	**8**	2	**62**	18	**345**
Layer 4 (340-700 cm dt.)	**257**	60	**43**	10	**21**	5	**109**	25	**430**
Layer 5 (400-470 cm dt.)	**115**	76	**16**	11	**1**		**19**	12	**151**
Layer 6 (470-520 cm dt.)	**4**		**0**		**0**		**5**	56	**9**
Layer 7 (520-580 cm dt.)	**66**	74	**9**	10	**0**		**14**	16	**89**
Layer 8 (580-720 cm dt.)	**95**	53	**15**	8	**12**	7	**57**	32	**179**
Layer 9 (620-740 cm dt.)	**77**	52	**14**	10	**8**	5	**48**	33	**147**
Layer 10 (700-780 cm dt.)	**14**	52	**3**		**0**		**10**	37	**27**
Total	**868**	63	**135**	10	**50**	4	**324**	23	**1377**

Table 4.3.5 Corticality of butt of the flakes across the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The "totally cortical" butts are by far the most frequent in the series (868/1377: 63%). The highest proportions are in the middle layers 5 and 7 (74-76%), afterwards in the upper layer 3 (70%). In the others layers, they represent slightly more than the half (50-60%), except in the layer 6 where the low number of specimens does not provide significant percentages. The “non-cortical” butts are in second position (324/1377: 23%). They are more frequent in the lower layers (8 to 10), where they occur on about one third of the flakes (32 to 37%). Also, the “cortical dominant” and “non-cortical dominant” are occasionally present in these sectors **(Table 4.3.5)**.

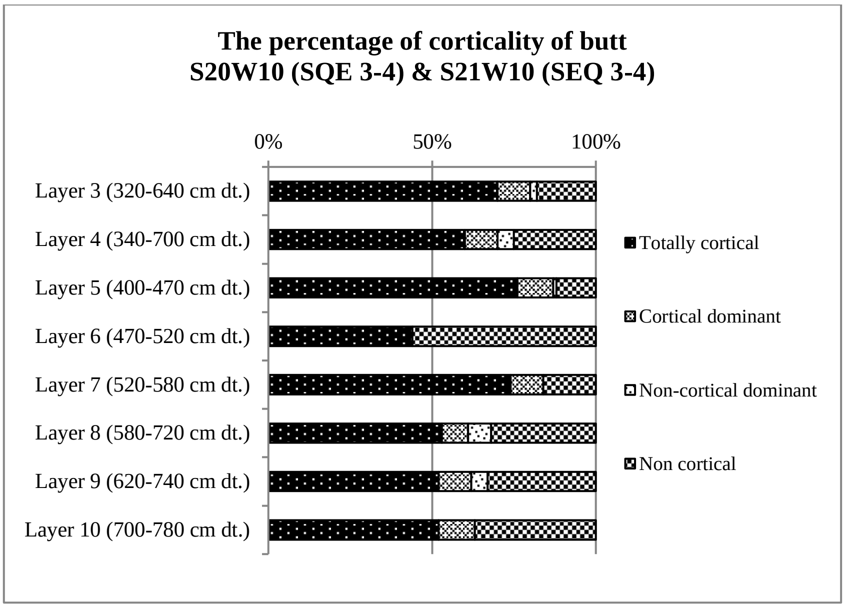


Figure 4.3.7 Distribution of the corticality of butt of the flakes across the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4.2) Type of butt (including facets)

Type of bulb S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Plane**		**Linear**		**Punctiform**		**Bifacetted**		**Multifa-cetted**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**243**	71	**0**		**34**	10	**15**	4	**53**	15	**345**
Layer 4 (340-700 cm dt.)	**271**	63	**88**	20	**46**	11	**12**	3	**13**	3	**430**
Layer 5 (400-470 cm dt.)	**115**	76	**0**		**5**	4	**26**	17	**5**	3	**151**
Layer 6 (470-520 cm dt.)	**8**	89	**0**		**1**		**0**		**0**		**9**
Layer 7 (520-580 cm dt.)	**71**	80	**0**		**4**		**13**	15	**1**		**89**
Layer 8 (580-720 cm dt.)	**116**	65	**30**	17	**10**	5	**12**	7	**11**	6	**179**
Layer 9 (620-740 cm dt.)	**103**	70	**9**	6	**6**	4	**13**	9	**16**	11	**147**
Layer 10 (700-780 cm dt.)	**14**	52	**6**	22	**5**	19	**2**		**0**		**27**
Total	**941**	68	**133**	10	**111**	8	**93**	7	**99**	7	**1377**

Table 4.3.6 Type of butt of the flakes across the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

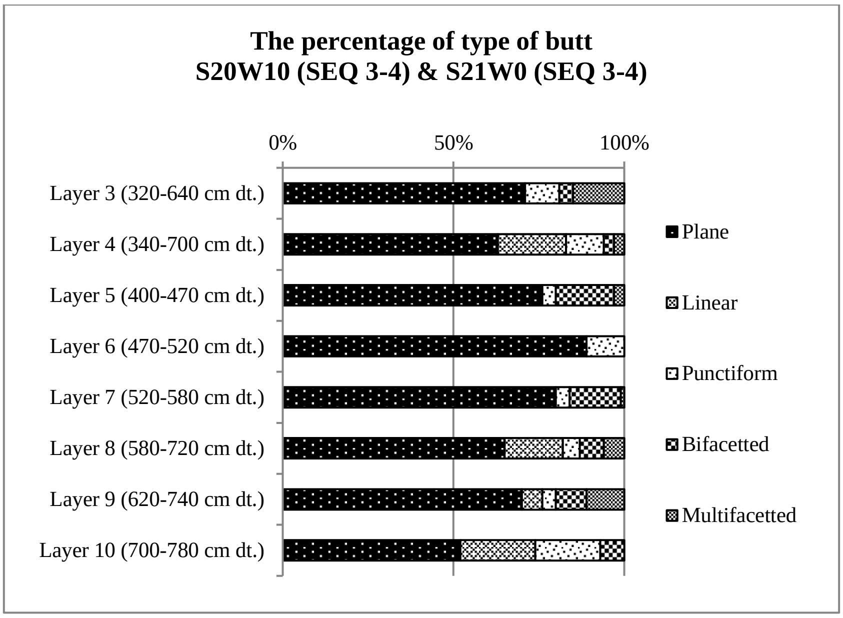


Figure 4.3.8 Distribution of the corticality of butt of the flakes across the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The striking platform of the blank flakes is usually plane in all the layers (941/1377: 68%). The most important proportion of plane platforms is in the middle layers, especially in the layers 6 and 7 (80% or more) where the linear and punctiform platforms are rare. The low proportion is in the bottom layers, especially in the layer 10 (14/27: 52%) but with a few specimens and therefore not really significant. In these lower layers the linear and punctiform platforms (stroke applied on the edge and not on one of the faces) are well represented. These types of platform may result from the sharpening of large tools. Bifacetted platforms are conspicuous in the middle layers 5 and 7, although around 15% only. The multifaceted platforms are especially well represented in the upper layer 3 but also in the layer 9. In the context of core reduction sequences they indicate preparation of the platforms and in the context of shaping they may correspond to bifacial sharpening of large tools **(Table 4.3.6, figure 4.3.8)**.

4.3) Angle of butt

Angle of butt **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Very-Acute**		**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**14**	4	**31**	9	**87**	25	**87**	25	**126**	37	**345**
Layer 4 (340-700 cm dt.)	**16**	4	**38**	9	**41**	9	**169**	39	**166**	39	**430**
Layer 5 (400-470 cm dt.)	**0**		**16**	11	**70**	46	**42**	28	**23**	15	**151**
Layer 6 (470-520 cm dt.)	**0**		**2**		**2**		**4**		**1**		**9**
Layer 7 (520-580 cm dt.)	**1**		**6**	7	**36**	40	**34**	38	**12**	14	**89**
Layer 8 (580-720 cm dt.)	**0**		**7**	4	**24**	13	**73**	41	**75**	42	**179**
Layer 9 (620-740 cm dt.)	**2**		**5**	3	**29**	20	**58**	40	**53**	36	**147**
Layer 10 (700-780 cm dt.)	**0**		**4**		**3**		**9**	33	**11**	41	**27**
Total	**33**	2	**109**	8	**292**	21	**476**	35	**467**	34	**1377**

Table 4.3.7 Angle of butt of the flakes across the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

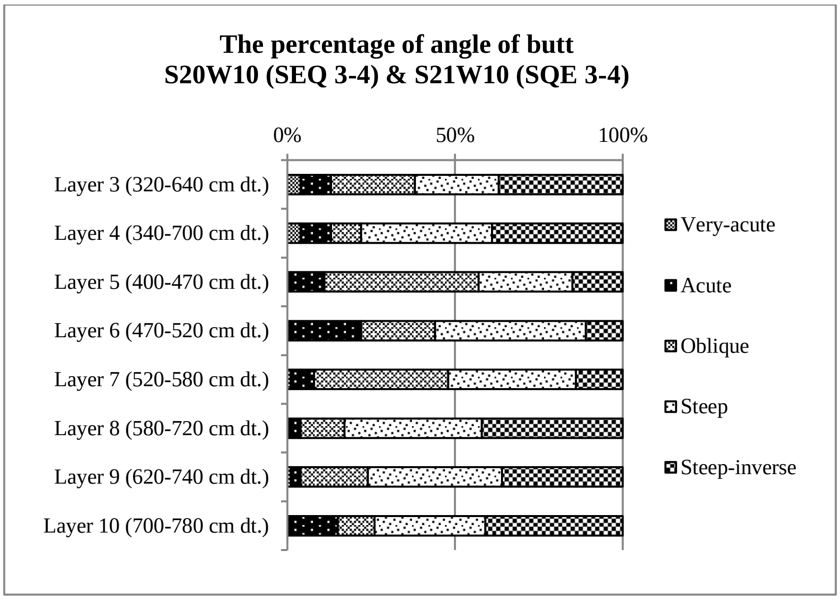


Figure 4.3.9 Distribution of the angle of butt of the flakes across the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

In the majority of the cases, the platform of the blank flakes makes an angle around 80°-100° categorized as “steep” or an angle around 110°-120° categorized as “inverse steep”. Oblique or acute angles are much less frequent, except in the middle layers 5 to 7. Usually such platform angles correspond to opening flakes **(Table 4.3.7)**.

The "steep" is representing 35% (476/1377) of the blank flakes and the most significant is in the layer 6 (45%), then the "steep-inverse" is the second portion, representing 34% (467/ 1377) and the layer 8 is by far the richest in the series: 42% (75/179). In the others, they are quite constant in numbers, except in the layer 6, where they are rarely recovered. The "oblique" is recovering 21% (292/1377), and there are quite variations in the layers, remarkably in the middle layers 5 and 7 (46-40%). The "acute" and "very-acute" are rarely frequent, less than 10% **(Table 4.3.7, figure 4.3.9)**.

5) Dorsal face of blank flakes

5.1) Amount of cortex

Amount of cortex S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Totally cortical**		**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**31**	9	**42**	12	**93**	27	**179**	52	**345**
Layer 4 (340-700 cm dt.)	**54**	13	**45**	10	**124**	29	**207**	48	**430**
Layer 5 (400-470 cm dt.)	**1**		**11**	7	**33**	22	**106**	70	**151**
Layer 6 (470-520 cm dt.)	**0**		**1**		**3**		**5**	56	**9**
Layer 7 (520-580 cm dt.)	**3**		**8**	9	**27**	30	**51**	57	**89**
Layer 8 (580-720 cm dt.)	**16**	9	**22**	12	**40**	22	**101**	57	**179**
Layer 9 (620-740 cm dt.)	**13**	9	**16**	11	**35**	24	**83**	56	**147**
Layer 10 (700-780 cm dt.)	**2**		**3**		**7**	26	**15**	56	**27**
Total	**120**	9	**148**	11	**362**	26	**747**	54	**1377**

Table 4.3.8 Amount of cortex on dorsal face of the flakes from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Around 9% (120/1377) of the flakes are "totally cortical" on the dorsal face. They represent the first stage of core reduction (or tool shaping). The next stage produces "cortical dominant" flakes which are hardly more than the former stage: about 11% (148/1377). Then the flakes with "non-cortical dominant" dorsal face is slightly more frequent: 26% (362/1377). The last stage of core reduction resulting in unretouched flakes devoid of cortex or "non-cortical" represents about 54% (747/1377). This stage is especially important in the middle layer 5 (70%), where also the flakes are smaller (see above). In the other layers, there are no important variations (**Table 4.3.8**).

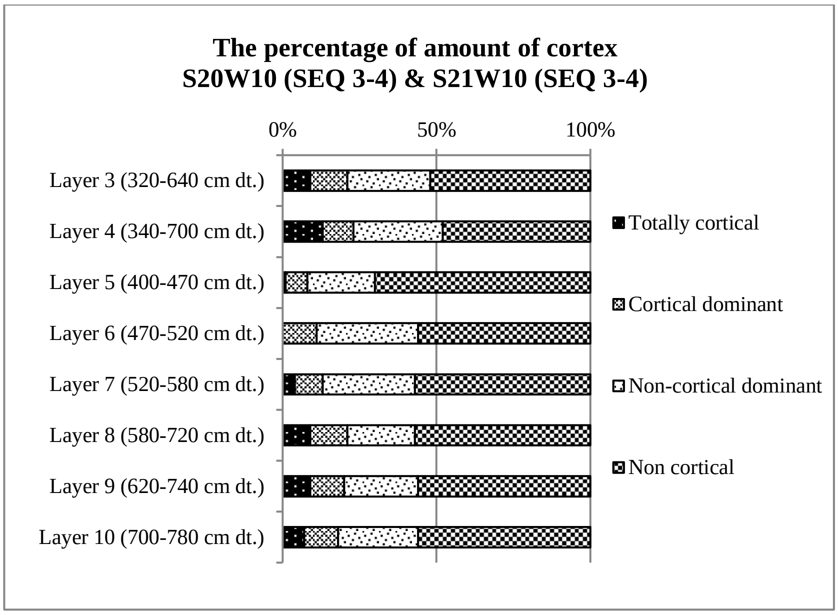


Figure 4.3.10 Distribution of the amount of cortex on dorsal face of the flakes from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

5.2) Direction of scars

Direction of scars **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Unipolar**		**Bipolar-opposite**		**Bidirectional -orthogonal**		**Three-directions**		**Convergent**		**Undeter-mined**		**Total**
Layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3	**222**	64	**48**	14	**9**	2	**9**	3	**10**	3	**47**	14	**345**
Layer 4	**153**	36	**57**	13	**23**	5	**15**	3	**38**	9	**144**	34	**430**
Layer 5	**105**	69	**35**	23	**3**		**3**		**4**		**1**		**151**
Layer 6	**4**		**2**		**1**		**1**		**1**		**0**		**9**
Layer 7	**57**	64	**22**	25	**1**		**0**		**5**	6	**4**		**89**
Layer 8	**109**	61	**15**	8	**8**	5	**0**		**8**	4	**39**	22	**179**
Layer 9	**95**	65	**19**	13	**2**		**2**		**9**	6	**20**	14	**47**
Layer 10	**12**	45	**2**		**3**		**2**		**6**	22	**2**		**27**
Total	**757**	55	**200**	14	**50**	4	**32**	2	**81**	6	**257**	19	**1377**

Table 4.3.9 Direction of scars on dorsal face of the flakes from Tham Lod Rockshelter, area 2, sectors S20W10 & S21W10 (SEQ 3-4)

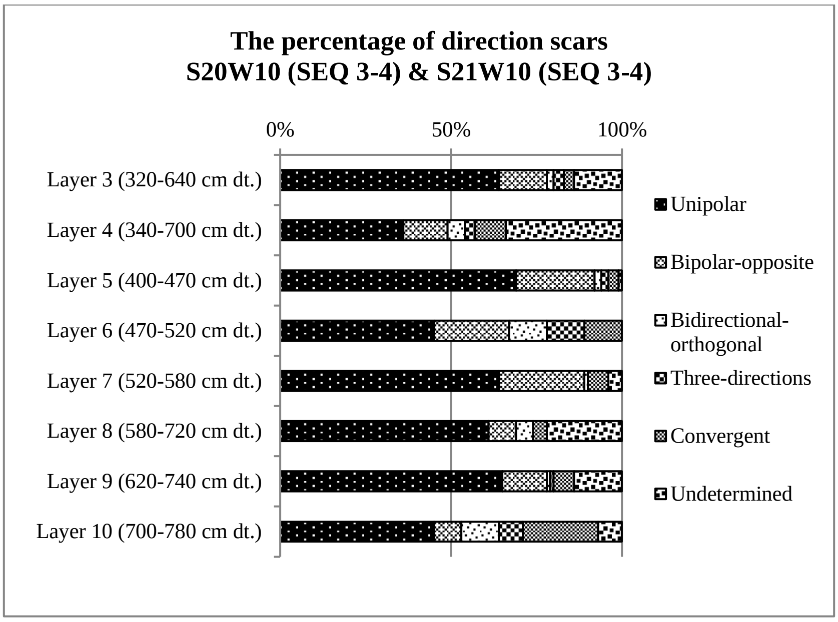


Figure 4.3.11 Distribution of the direction of scars on dorsal face of the flakes from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The flakes on the dorsal scar pattern are more “unipolar”, for about 55% (757/1377). A similar number is in the layers 5 and 8, for about 105-109 items. On the other hand, the layer 5 is the most considerable in the series, providing 70% (105/151). The lowest is in the upper layer 4 (36%). Generally, the unipolar pattern is provided by cores with one single striking platform or from the chopper shaping, if the dorsal faces are partly cortical. However, it should be noted that in the layer 4, the number of “undetermined” (144 items) is quite remarkable in the series **(Table 4.3.9, figure 4.3.11)**.

5.3) Number of scars

Number of scars **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**1Scar**		**2Scars**		**3Scars**		**4Scars**		**5Scars**		**6Scars**		**7Scars**		**>8Scars**		**Undeter-mined**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**54**	16	**91**	26	**72**	21	**38**	11	**18**	5	**11**	3	**5**	2	**4**		**52**	15	**345**
Layer 4 (340-700 cm dt.)	**46**	11	**64**	15	**42**	10	**44**	10	**32**	7	**18**	4	**13**	3	**26**	6	**145**	34	**430**
Layer 5 (400-470 cm dt.)	**17**	11	**57**	38	**44**	29	**15**	10	**13**	9	**2**		**1**		**2**		**0**		**151**
Layer 6 (470-520 cm dt.)	**3**		**1**		**3**		**1**		**0**		**0**		**0**		**1**		**0**		**9**
Layer 7 (520-580 cm dt.)	**18**	20	**27**	30	**21**	24	**7**	8	**7**	8	**2**		**1**		**2**		**4**		**89**
Layer 8 (580-720 cm dt.)	**24**	13	**54**	30	**25**	14	**24**	13	**8**	5	**0**		**0**		**2**		**42**	24	**179**
Layer 9 (620-740 cm dt.)	**13**	9	**64**	44	**21**	14	**11**	7	**9**	6	**4**		**1**		**3**		**21**	14	**147**
Layer 10 (700-780 cm dt.)	**1**		**5**	18	**8**	30	**2**		**5**	19	**1**		**2**		**2**		**1**		**27**
Total	**176**	13	**363**	26	**236**	17	**142**	10	**92**	6	**38**	3	**23**	2	**42**	3	**265**	19	**1377**

Table 4.3.10 Number of scars on the dorsal face of flakes from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

5.4) Number of arrises

Number of Arris **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**1 Arris**		**2 Arrises**		**3 Arrises**		**4 Arrises**		**5Arrises**		**6 Arrises**		**7Arrises**		**>8 Arrises**		**Undeter-mined**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**135**	39	**63**	18	**34**	10	**31**	9	**14**	4	**11**	3	**0**		**4**		**53**	16	**345**
Layer 4 (340-700 cm dt.)	**103**	24	**43**	10	**43**	10	**26**	6	**22**	5	**14**	3	**10**	2	**24**	6	**145**	34	**430**
Layer 5 (400-470 cm dt.)	**73**	48	**42**	28	**14**	9	**13**	9	**6**	4	**0**		**1**		**2**		**0**		**151**
Layer 6 (470-520 cm dt.)	**4**		**2**		**2**		**0**		**0**		**0**		**1**		**0**		**0**		**9**
Layer 7 (520-580 cm dt.)	**42**	47	**17**	19	**12**	14	**9**	10	**2**		**1**		**1**		**1**		**4**		**89**
Layer 8 (580-720 cm dt.)	**76**	42	**23**	13	**21**	12	**13**	7	**2**		**0**		**0**		**2**		**42**	24	**179**
Layer 9 (620-740 cm dt.)	**71**	48	**23**	16	**12**	8	**8**	5	**4**		**3**		**1**		**3**		**22**	15	**147**
Layer 10 (700-780 cm dt.)	**5**	19	**6**	22	**6**	22	**4**		**0**		**2**		**1**		**2**		**1**		**27**
Total	**509**	37	**219**	16	**144**	10	**104**	8	**50**	4	**31**	2	**15**	1	**38**	3	**267**	19	**1377**

Table 4.3.11 Number of arrises on the dorsal face of flakes from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

In all the flakes with scars, the number of flake scars mostly 2 scars (363/1377: 26%). The highest proportion is in the lower layer 9, at almost 45% (64/147), followed by the layer 5 with 38% (57/151), and afterwards in the layers 7 and 8, with about 30% **(Table 4.3.10)**. It is to be noted that the flakes with undetermined number of scars is rather high: 20% (265/1377). And the maximal number in the series is in the layer 4 (145/430: 34%).

In the whole flakes with arrises, the most significant number is 1 arris (509/1377: 37%). Generally, the percentages are somewhat constant in numbers from the upper to lower layers, for about 39-48%, with the exception of the layers 4 and 10, where they are quite in low proportions, mainly in the bottom (layer 10, 5/27: 20%) **(Table 4.3.11)**.

6) General morphology of the blank flakes

In the frontal view, the irregular shape is more noticeable in these sectors, presenting (596/ 1377: 43%). The most significant value is in the middle layers (5 to 7), with about 56-70%, mainly in the layer 7. The trapezoidal shape is the second, providing nearly 25% (325/1377). From the upper to lower layers, the percentages are quite constant in numbers (22-30%) **(Table 4.3.12)**.

The trapezoidal and triangular shapes of sagittal view are markedly frequent in these sectors. The trapezoidal shape is by far the richest in the series, providing (409/1377: 30%). The triangular shape is quite similar in percentage: 28% (390/1377). The most significant are in the middle layers, mainly in the layers (5: 42% and 7: 40%). The lowest one is in the layer 4, to about (91/430: 21%) **(Table 4.3.13)**.

In the transversal view, the triangular shape is more common than the other shapes in these sectors (501/1377: 36%). The greatest proportions are in the middle layers (5: 50%) **(Table 4.3.14)**.

6.1) Frontal morphology

Frontal view S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Irregular**		**Trape-zoidal**		**Oval**		**Trian-gular**		**Circular**		**Penta-gonal**		**D-shape**		**Bi-convex**		**Almond**		**Half-oval**		**Quadran-gular**		**Right triangular**		**Poly-gonal**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**163**	47	**75**	22	**32**	10	**30**	9	**15**	4	**16**	5	**10**	3	**1**		**1**		**1**		**0**		**0**		**1**		**345**
Layer 4 (340-700 cm dt.)	**165**	38	**106**	25	**61**	15	**26**	6	**31**	7	**14**	3	**16**	4	**1**		**4**		**2**		**2**		**1**		**1**		**430**
Layer 5 (400-470 cm dt.)	**92**	61	**35**	23	**5**	3	**11**	7	**1**		**6**	4	**0**		**0**		**1**		**0**		**0**		**0**		**0**		**151**
Layer 6 (470-520 cm dt.)	**5**	56	**2**		**0**		**1**		**0**		**1**		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**9**
Layer 7 (520-580 cm dt.)	**62**	70	**9**	10	**4**		**8**	9	**1**		**4**		**0**		**0**		**0**		**1**		**0**		**0**		**0**		**89**
Layer 8 (580-720 cm dt.)	**58**	32	**53**	30	**21**	11	**19**	11	**6**	3	**12**	7	**5**	3	**0**		**0**		**4**		**0**		**1**		**0**		**179**
Layer 9 (620-740 cm dt.)	**49**	33	**43**	29	**13**	9	**14**	10	**7**	5	**5**	3	**6**	4	**5**	3	**2**		**0**		**1**		**1**		**1**		**147**
Layer 10 (700-780 cm dt.)	**2**		**2**		**9**	33	**2**		**3**		**4**		**0**		**3**		**0**		**0**		**1**		**1**		**0**		**27**
Total	**596**	43	**325**	24	**145**	11	**111**	8	**64**	5	**62**	5	**37**	3	**10**	1	**8**	1	**8**	1	**4**		**4**		**3**		**1377**

Table 4.3.12 The frontal morphology of flakes from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

6.2) Sagittal morphology

Sagittal view S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Trape-zoidal**		**Triangular**		**Irregular**		**Right triangular**		**D-shape**		**Almond**		**Bi-convex**		**Oval**		**Pentagonal**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-340 cm dt.)	**104**	30	**93**	27	**50**	14	**31**	9	**27**	8	**13**	4	**6**	2	**20**	6	**1**		**345**
Layer 4 (340-400 cm dt.)	**114**	26	**91**	21	**50**	12	**66**	15	**40**	9	**33**	8	**24**	6	**8**	2	**4**		**430**
Layer 5 (400-470 cm dt.)	**55**	36	**64**	42	**24**	16	**0**		**7**	5	**0**		**0**		**0**		**1**		**151**
Layer 6 (470-520 cm dt.)	**4**		**3**		**1**		**0**		**1**		**0**		**0**		**0**		**0**		**9**
Layer 7 (520-580 cm dt.)	**25**	28	**36**	40	**22**	25	**0**		**1**		**0**		**0**		**5**	6	**0**		**89**
Layer 8 (580-620 cm dt.)	**55**	31	**48**	27	**12**	7	**37**	21	**14**	8	**6**	3	**4**		**2**		**1**		**179**
Layer 9 (620-700 cm dt.)	**42**	28	**45**	31	**14**	9	**22**	15	**12**	8	**1**		**3**		**4**		**4**		**147**
Layer 10 (700-720 cm dt.)	**10**	37	**10**	37	**1**		**4**		**0**		**0**		**2**		**0**		**0**		**27**
Total	**409**	30	**390**	28	**174**	13	**160**	12	**102**	7	**53**	4	**39**	3	**39**	3	**11**	1	**1377**

Table 4.3.13 The sagittal morphology of flakes from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

6.3) Transversal morphology

Transversal view S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Triangular**		**Trape-zoidal**		**Irregular**		**Almond**		**Oval**		**Right triangular**		**Pentagonal**		**D-shape**		**Bi-convex**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**142**	41	**54**	16	**49**	14	**49**	14	**27**	8	**13**	4	**2**		**6**	2	**3**		**345**
Layer 4 (340-700 cm dt.)	**140**	33	**73**	17	**51**	12	**62**	14	**16**	4	**40**	9	**1**		**24**	6	**23**	5	**430**
Layer 5 (400-470 cm dt.)	**73**	49	**27**	18	**26**	17	**0**		**23**	15	**0**		**0**		**2**		**0**		**151**
Layer 6 (470-520 cm dt.)	**5**	56	**2**		**1**		**0**		**1**		**0**		**0**		**0**		**0**		**9**
Layer 7 (520-580 cm dt.)	**0**		**13**	15	**15**	17	**0**		**8**	9	**0**		**52**	58	**1**		**0**		**89**
Layer 8 (580-720 cm dt.)	**71**	40	**33**	18	**30**	17	**15**	8	**5**	3	**13**	7	**0**		**10**	6	**2**		**179**
Layer 9 (620-740 cm dt.)	**63**	43	**31**	21	**16**	11	**10**	7	**6**	4	**10**	7	**1**		**7**	5	**3**		**147**
Layer 10 (700-780 cm dt.)	**7**	26	**5**	19	**2**		**0**		**3**		**5**	19	**0**		**0**		**5**	18	**27**
Total	**501**	36	**238**	17	**190**	14	**136**	10	**89**	6	**81**	6	**56**	4	**50**	4	**36**	3	**1377**

Table 4.3.14 The transversal morphology of flakes from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

7) Angle of the edges of the blank flakes

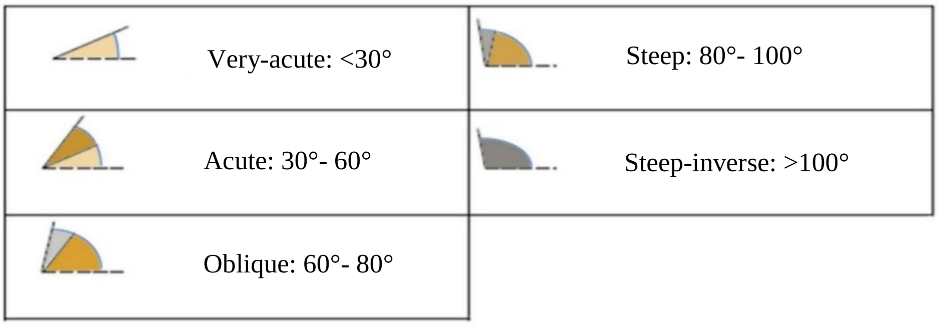


Figure 4.3.12 Categories of angles used to assessing the edge angle of the flakes across the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

7.1) Angle of the right and left sides

Right side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Very-acute**		**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**95**	27	**192**	56	**24**	7	**10**	3	**24**	7	**345**
Layer 4 (340-700 cm dt.)	**110**	25	**218**	51	**37**	9	**50**	12	**15**	3	**430**
Layer 5 (400-470 cm dt.)	**0**		**138**	92	**9**	6	**2**		**2**		**151**
Layer 6 (470-520 cm dt.)	**0**		**8**	89	**1**		**0**		**0**		**9**
Layer 7 (520-580 cm dt.)	**2**		**73**	82	**7**	8	**4**		**3**		**89**
Layer 8 (580-720 cm dt.)	**26**	15	**95**	53	**17**	9	**23**	13	**18**	10	**179**
Layer 9 (620-740 cm dt.)	**6**	4	**99**	67	**14**	10	**12**	8	**16**	11	**147**
Layer 10 (700-780 cm dt.)	**5**	18	**10**	37	**8**	30	**3**		**1**		**27**
Total	**244**	18	**833**	60	**117**	8	**104**	8	**79**	6	**1377**

Left side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Very-acute**		**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**102**	30	**193**	56	**25**	7	**15**	4	**10**	3	**345**
Layer 4 (340-700 cm dt.)	**136**	31	**214**	50	**39**	9	**33**	8	**8**	2	**430**
Layer 5 (400-470 cm dt.)	**0**		**131**	87	**13**	8	**4**		**3**		**151**
Layer 6 (470-520 cm dt.)	**0**		**7**	78	**2**		**0**		**0**		**9**
Layer 7 (520-580 cm dt.)	**3**		**70**	79	**9**	10	**7**	8	**0**		**89**
Layer 8 (580-720 cm dt.)	**40**	22	**96**	54	**20**	11	**19**	11	**4**		**179**
Layer 9 (620-740 cm dt.)	**12**	8	**91**	62	**19**	13	**16**	11	**9**	6	**147**
Layer 10 (700-780 cm dt.)	**4**		**11**	41	**3**		**8**	29	**1**		**127**
Total	**297**	22	**813**	59	**130**	9	**102**	7	**35**	3	**1377**

Table 4.3.15 Angle of right and left sides of the flakes from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

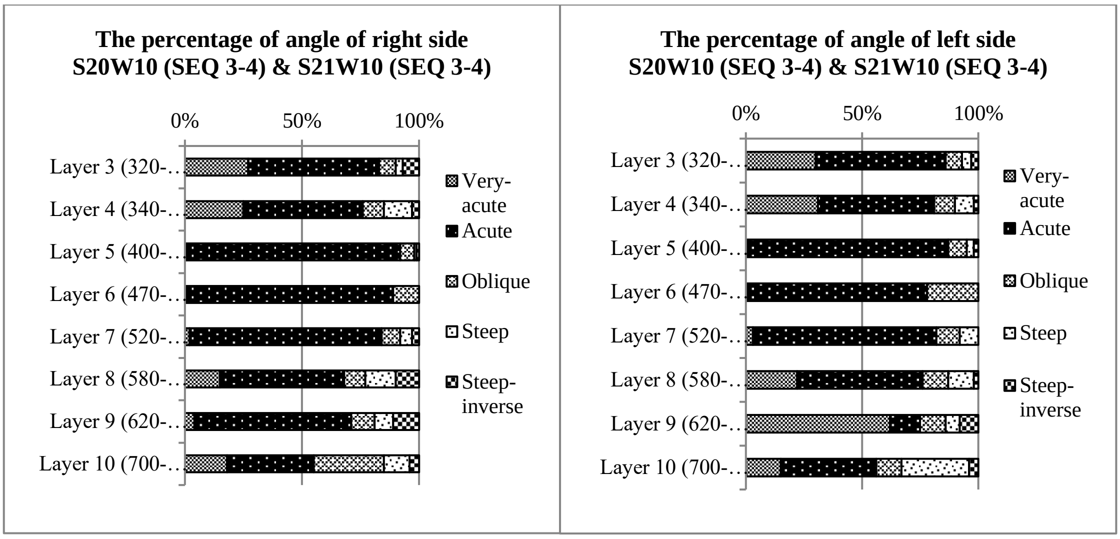


Figure 4.3.13 Distribution of the angle of right and left sides of the flakes from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

7.2) Angle of the distal side

Distal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Very-acute**		**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**121**	35	**177**	51	**26**	8	**8**	2	**13**	4	**345**
Layer 4 (340-700 cm dt.)	**166**	39	**197**	46	**23**	5	**29**	7	**15**	3	**430**
Layer 5 (400-470 cm dt.)	**0**		**137**	91	**6**	4	**4**		**4**		**151**
Layer 6 (470-520 cm dt.)	**0**		**9**	100	**0**		**0**		**0**		**9**
Layer 7 (520-580 cm dt.)	**2**		**79**	89	**6**	7	**1**		**1**		**89**
Layer 8 (580-720 cm dt.)	**43**	24	**83**	46	**20**	11	**18**	10	**15**	9	**79**
Layer 9 (620-740 cm dt.)	**24**	16	**86**	58	**7**	5	**14**	10	**16**	11	**147**
Layer 10 (700-780 cm dt.)	**4**		**13**	48	**3**		**5**	19	**2**		**27**
Total	**360**	26	**781**	57	**91**	6	**79**	6	**66**	5	**1377**

Table 4.3.16 Angle of distal side of the flakes from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

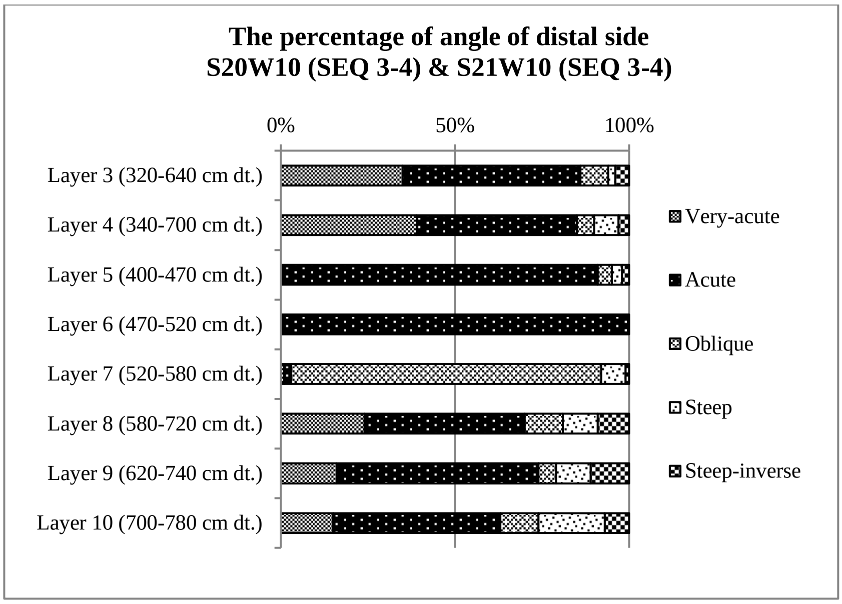


Figure 4.3.14 Distribution of the angle of distal side of the flakes from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

7.3) Angle of the proximal side

Proximal side S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Very-Acute**		**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**16**	5	**31**	9	**49**	14	**74**	21	**175**	51	**345**
Layer 4 (340-700 cm dt.)	**13**	3	**49**	11	**82**	19	**161**	38	**125**	29	**430**
Layer 5 (400-470 cm dt.)	**0**		**8**	5	**10**	7	**24**	16	**109**	72	**151**
Layer 6 (470-520 cm dt.)	**0**		**1**		**0**		**5**	56	**3**		**9**
Layer 7 (520-580 cm dt.)	**0**		**4**		**14**	16	**24**	24	**47**	53	**86**
Layer 8 (580-720 cm dt.)	**1**		**11**	6	**31**	17	**82**	46	**54**	30	**179**
Layer 9 (620-740 cm dt.)	**2**		**9**	6	**29**	20	**33**	23	**74**	50	**147**
Layer 10 (700-780 cm dt.)	**1**		**4**		**3**		**8**	29	**11**	41	**127**
Total	**33**	2	**117**	9	**218**	16	**411**	30	**598**	43	**1377**

Table 4.3.17 Angle of proximal side of the flakes from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

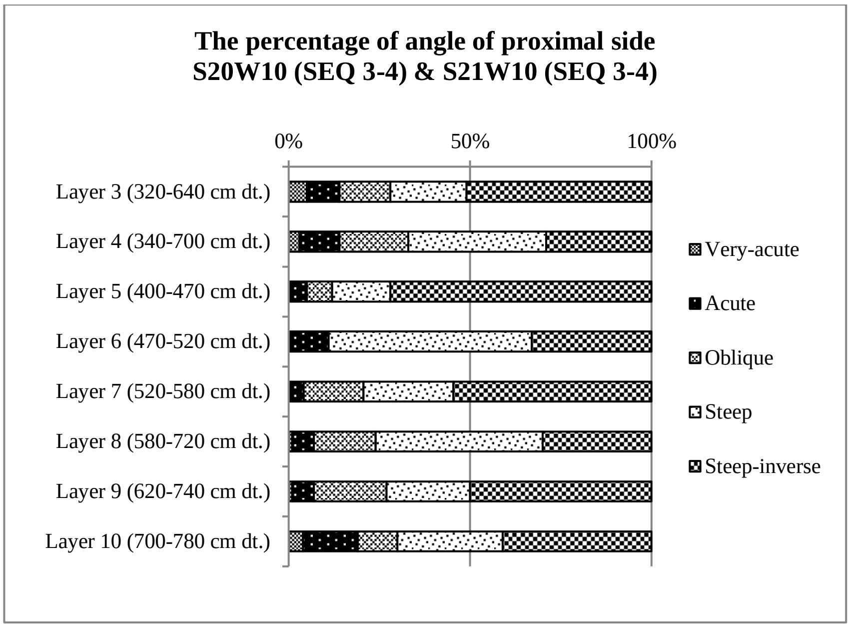


Figure 4.3.15 Distribution of the angle of proximal side of the flakes from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The edges are mostly “acute” (30°-60°) on the lateral and distal sides of the flakes **(Tables 4.3.15 & 4.3.16)**. They are also “very acute” in more than 25-30% of the cases in the upper layers 3 and 4, especially on the distal position (layer 3, 35%; layer 4, 39%).

The angle of the proximal side is of course more open since it corresponds to the striking platform. It is usually “steep-inverse” (100°-120°) or “steep” (80°-100°) **(Table 4.3.17)**.

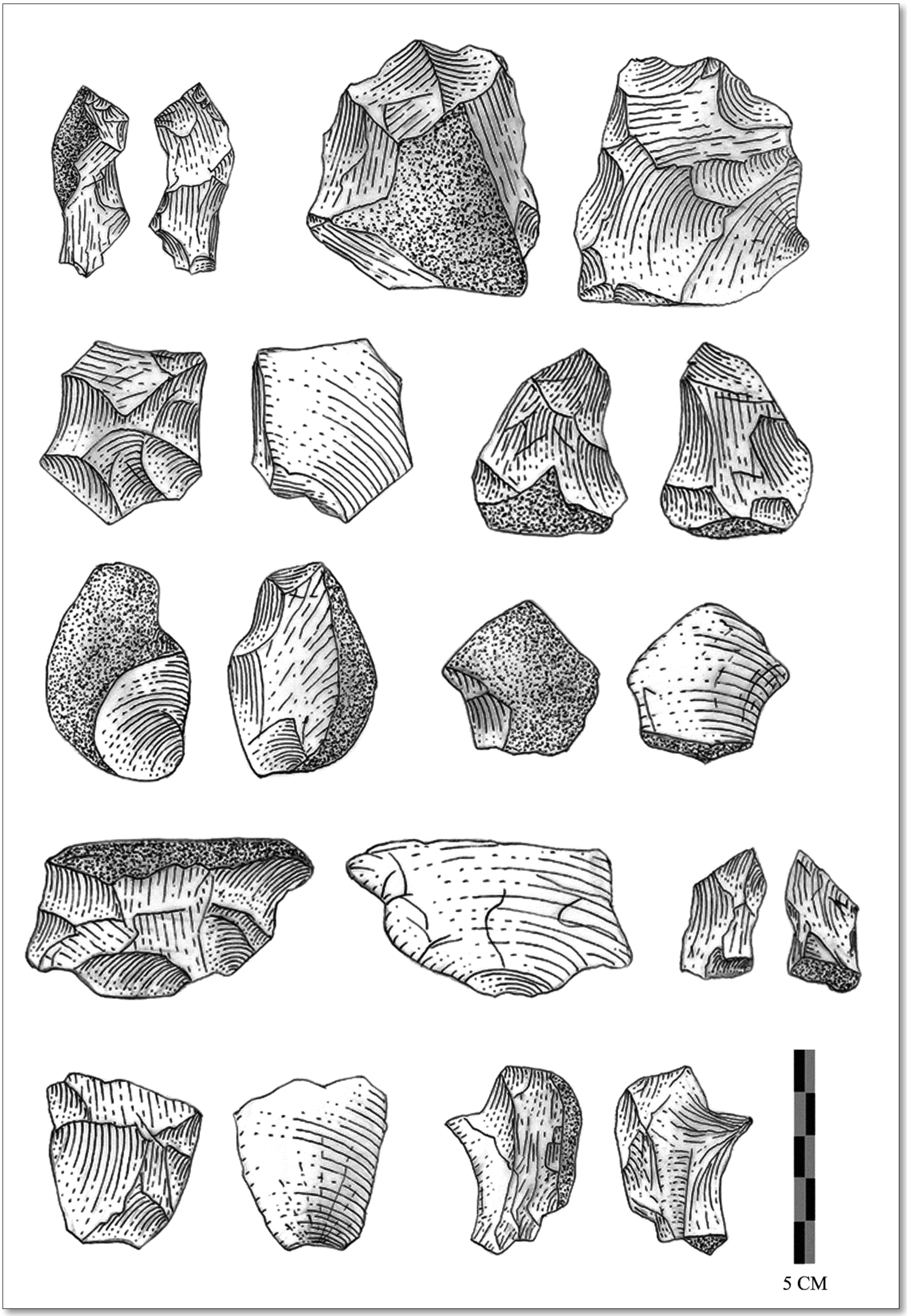


Figure 4.3.16 Flakes from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layers 3 and 4 (drawings T. Chitkament)

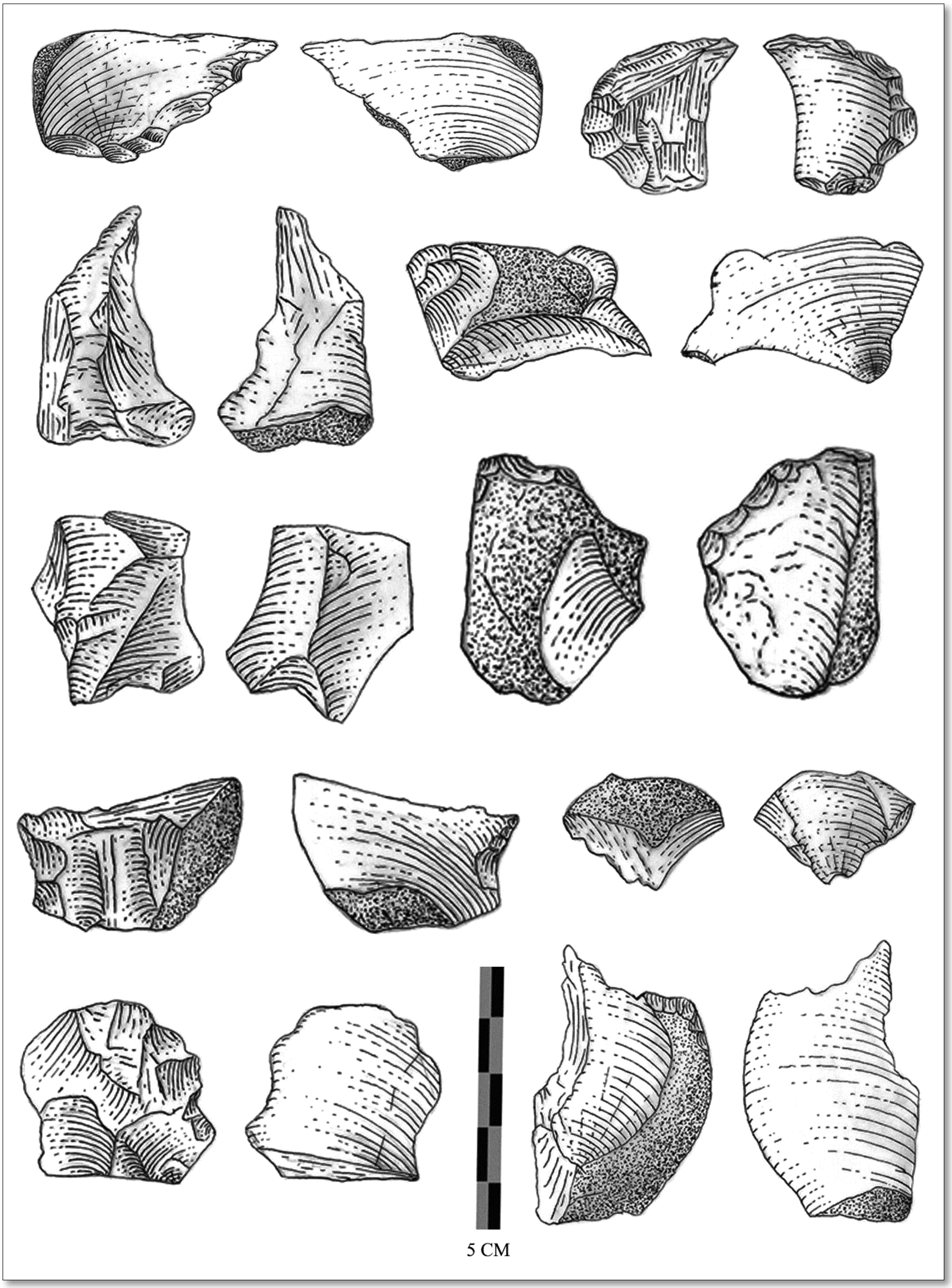


Figure 4.3.17 Flakes from Tham Lod Rockshelter, area 2 sector S21W10 (SEQ 3-4): layers 5, 6 and 7 (drawings T.Chitkament)

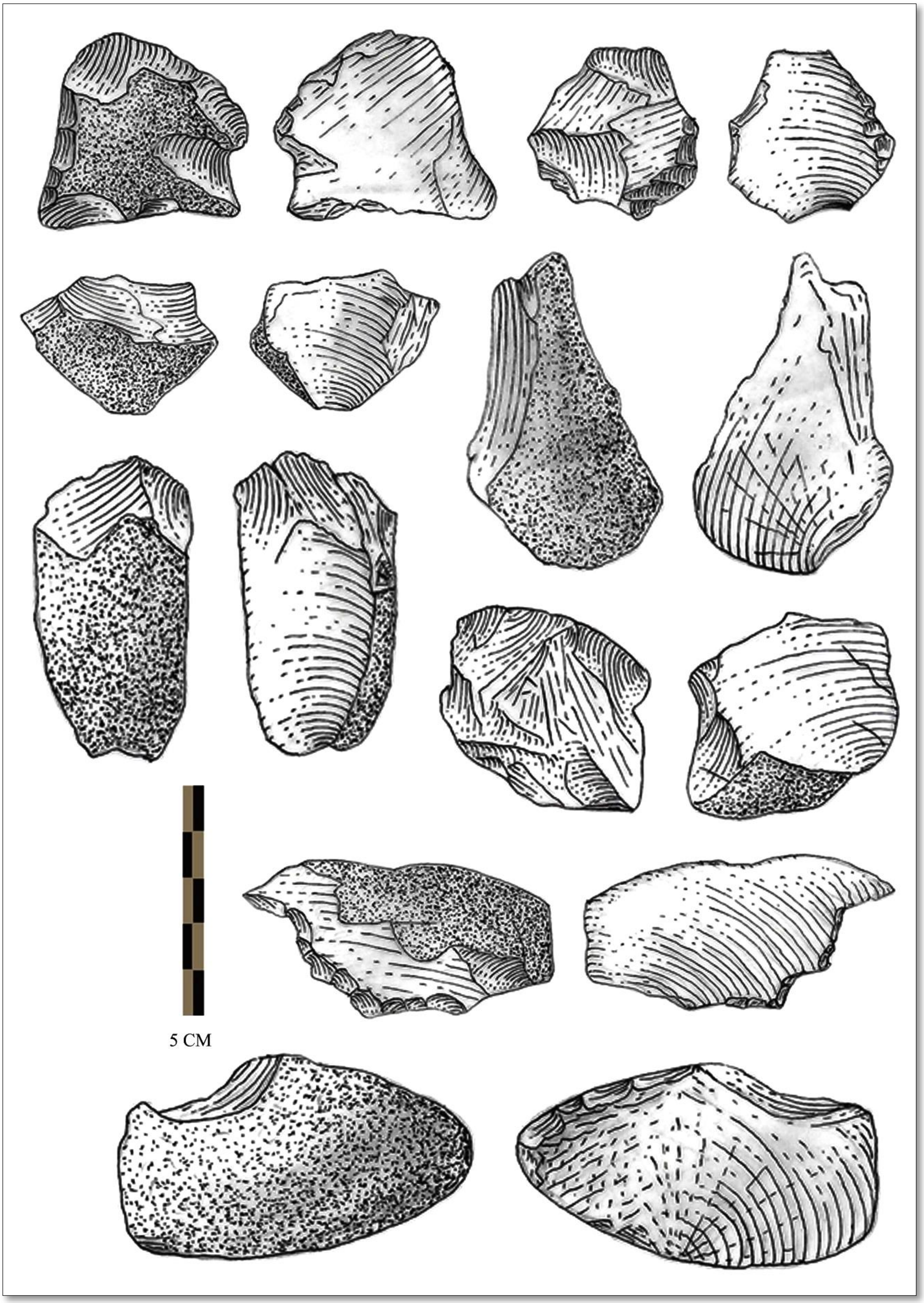


Figure 4.3.18 Flakes from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layers 8, 9 and 10 (drawings T. Chitkament)

4.4 Analysis of large tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4.4.1 General features of the large tools

The large tools from the stratigraphic layers 3 to 10 of area 2 sectors S20W10 and S21W10 are 383 in total (3% of the total number of artefacts). They comprise two main groups of tools: the choppers (rather thick) and the sumatralith (rather thin). In the first group, besides the "classical" end choppers and side choppers, varieties of other choppers are observed: corner choppers, nosed choppers, pointed choppers, double and multiple choppers, denticulated choppers and choppers with a very steep and convex edge (horse-hoof). These varieties are represented only by a few items and will be considered together as "other choppers". The sumatralith group includes typical sumatraliths, unifacially shaped all around but also numerous tools which are not shaped all around and thus are not typical, but their overall shape is very close to that of the sumatraliths; they will be called "partial sumatralith" (sumatralith partly shaped), a few of them being bifacially shaped.

The end choppers are overwhelming in the series, providing 102 specimens, followed by the sumatraliths, 84 specimens and afterwards by the side choppers, 56 specimens. It should be noted that the group of other choppers combined together is noticeably important, with 96 specimens. However, the nosed choppers, unifacial discoids and ½ bifacial tools are infrequent in these sectors.

Generally, the layer 4 is clearly apart, because the sumatralith group is more important (59% of the large tools, with a few partial sumatralith only) than the chopper group representing about 41%. In all other layers, this is reverse, but, in the upper layer 3, the chopper group represents about 62%, while, in the lower layers, it includes more than 80% of the large tools: only some typical sumatraliths and a few partial ones in the layers 8 and 9, and not at all in the layer 10. However, in the middle layers 5 and 6, the large tools are very few **(Table 4.4.2, figure 4.4.1)**.

Large tools **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Layer 3**		**Layer 4**		**Layer 5**		**Layer 6**		**Layer 7**		**Layer 8**		**Layer 9**		**Layer 10**		**Total**
Number (%)	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Corner chopper	**3**		**2**		**0**		**0**		**1**		**5**	8	**1**		**0**		**12**
Double chopper	**13**	9	**3**		**0**		**1**		**1**		**5**	8	**1**		**1**		**25**
End chopper	**40**	28	**12**	14	**3**		**3**		**20**	52	**8**	13	**13**	35	**3**		**102**
Extended chopper	**0**		**1**		**0**		**0**		**0**		**1**		**4**		**1**		**7**
Giant chopper	**5**	4	**0**		**0**		**0**		**0**		**0**		**0**		**1**		**6**
Nosed chopper	**0**		**0**		**0**		**0**		**0**		**0**		**1**		**1**		**2**
Multiple chopper	**5**	4	**0**		**0**		**1**		**6**	15	**4**		**2**		**0**		**18**
Pointed chopper	**1**		**1**		**0**		**3**		**0**		**3**		**0**		**3**		**11**
Side chopper	**13**	9	**12**	14	**2**		**2**		**3**		**17**	28	**6**	16	**1**		**56**
Steep chopper	**4**		**0**		**0**		**0**		**0**		**2**		**0**		**0**		**6**
Denticulated chopper	**2**		**2**		**0**		**0**		**0**		**4**		**1**		**0**		**9**
Unifacial discoid	**0**		**2**		**0**		**0**		**0**		**0**		**1**		**0**		**3**
Sumatralith	**26**	19	**36**	46	**2**		**3**		**5**	13	**7**	12	**5**	14	**0**		**84**
½ Sumatralith	**4**		**1**		**0**		**0**		**1**		**2**		**0**		**0**		**8**
¾ Sumatralith	**4**		**2**		**0**		**1**		**1**		**0**		**1**		**0**		**9**
½ Bifacial tool	**1**		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**1**
Partly unifacial tool	**12**	9	**2**		**0**		**0**		**0**		**1**		**0**		**0**		**15**
Partly bifacial tool	**5**	4	**3**		**0**		**0**		**0**		**1**		**0**		**0**		**9**
Total	**138**	36	**79**	20	**7**	2	**14**	4	**38**	10	**60**	16	**36**	9	**11**	3	**383**

Table 4.4.1 Total number of large tools in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Large tools **S20W10(SEQ 3-4) & S21W10 (SEQ 3-4)**	**End chopper**		**Side chopper**		**Other choppers**		**Sumatra-lith**		**Partial sumatralith (unifacial)**		**Partial sumatralith (bifacial)**		**Unifacial discoid**		**Total**
Layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3	**40**	29	**13**	9	**33**	24	**26**	19	**20**	15	**6**	4	**0**		**138**
Layer 4	**12**	15	**12**	15	**9**	11	**36**	46	**5**	6	**3**		**2**		**79**
Layer 5	**3**		**2**		**0**		**2**		**0**		**0**		**0**		**7**
Layer 6	**3**		**2**		**5**	36	**3**		**1**		**0**		**0**		**14**
Layer 7	**20**	53	**3**		**8**	21	**5**	13	**2**		**0**		**0**		**38**
Layer 8	**8**	13	**17**	28	**24**	40	**7**	12	**3**		**1**		**0**		**60**
Layer 9	**13**	36	**6**	16	**10**	28	**5**	14	**1**		**0**		**1**		**36**
Layer 10	**3**		**1**		**7**	64	**0**		**0**		**0**		**0**		**11**
Total	**102**	27	**56**	15	**96**	25	**84**	22	**32**	8	**10**	2	**3**	1	**383**

Table 4.4.2 Distribution of the main categories of large tools in the stratigraphic sequence of sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4), area 2 of Tham Lod Rockshelter

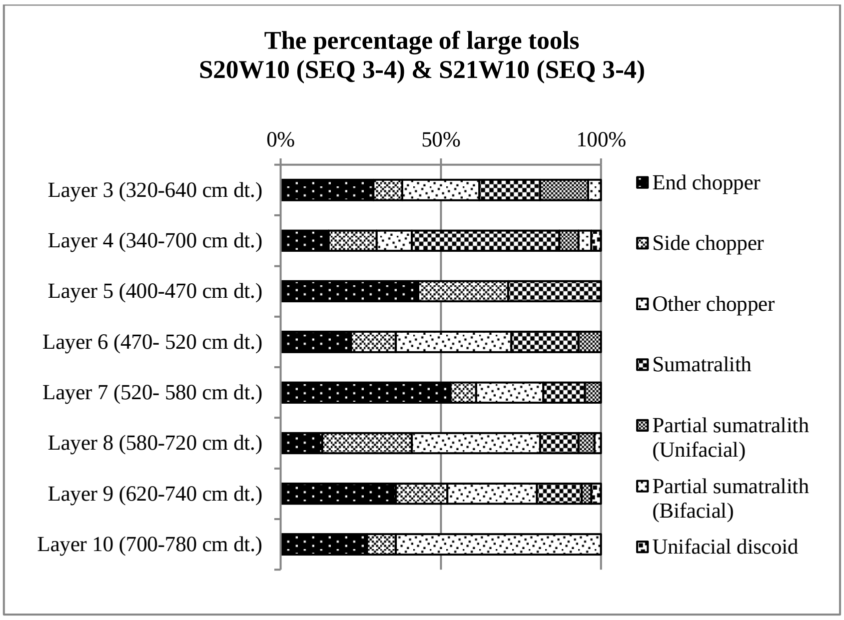


Figure 4.4.1 Distribution of the main categories of large tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The main categories of large tools are distributed as we can see above **(Table 4.4.2)**. The end choppers are more frequent than the side chopper in all the layers, except the layer 8. In the lower layers 10 to 8, the category of "other choppers" represents at least half of the choppers while in the middle and upper layers they are much less, except in the layer 6, which may not be significant due to the small amount of large tools. The proportion of sumatraliths increases gradually from layer 9 to layer 4 then decreases slightly in the layer 3, where the partial sumatraliths are as many as the typical ones.

Raw materials **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Gray sandstone**		**Black sandstone**		**Quart-zite**		**Mudstone**		**Siliceous shale**		**Quartz**		**Andesite**		**Total**
Layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3	**127**	92	**5**	4	**2**		**1**		**2**		**1**		**0**		**138**
Layer 4	**76**	96	**2**		**1**		**0**		**0**		**0**		**0**		**79**
Layer 5	**7**	100	**0**		**0**		**0**		**0**		**0**		**0**		**7**
Layer 6	**13**	93	**1**		**0**		**0**		**0**		**0**		**0**		**14**
Layer 7	**36**	95	**2**		**0**		**0**		**0**		**0**		**0**		**38**
Layer 8	**54**	90	**2**		**2**		**0**		**1**		**0**		**1**		**60**
Layer 9	**33**	92	**2**		**1**		**0**		**0**		**0**		**0**		**36**
Layer 10	**9**	82	**0**		**1**		**0**		**0**		**1**		**0**		**11**
Total	**355**	93	**14**	4	**7**	2	**1**	0	**3**	1	**2**	0	**1**	0	**383**

Table 4.4.3 The raw materials of large tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The gray sandstones are the most frequent in each layer, representing 93% of the large tools. The maximal percentage is in the layer 5 and the minimal is in the bottom layer 10 (82%: 9/11), but in both of them, their numbers are very small, less than 10 specimens. The other raw materials such as black sandstone, quartzite, mudstone, siliceous shale, quartz and andesite are rarely represented and, therefore, the percentages are statistically not significant **(Table 4.4.3)**.

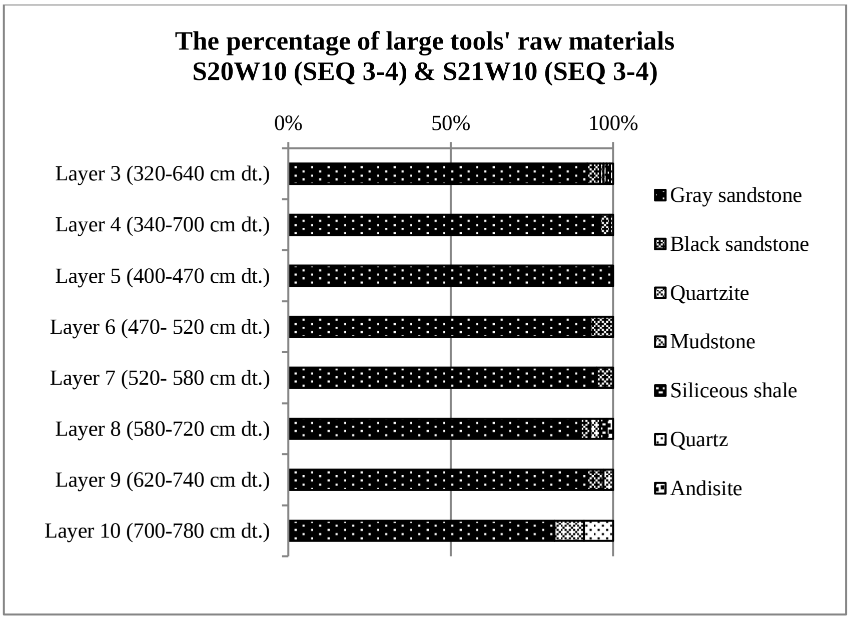


Figure 4.4.2 Distribution of the raw materials of large tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Weight (gr.) **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**<200**	**201-400**	**401-600**	**601-800**	**801-1000**	**1001-1200**	**1201-1400**	**1401-1600**	**1601-1800**	**>1800**	**Total**
Layer 3	5	32	34	20	17	2	8	5	5	10	**138**
Layer 4	1	23	35	11	3	2	1	1	0	2	**79**
Layer 5	2	0	1	1	0	0	0	1	0	2	**7**
Layer 6	0	3	3	1	2	1	2	0	0	2	**14**
Layer 7	1	6	8	4	5	4	1	2	2	5	**38**
Layer 8	0	14	15	6	12	6	3	3	1	0	**60**
Layer 9	4	8	11	7	1	1	0	1	2	1	**36**
Layer 10	0	2	0	2	3	1	0	2	0	1	**11**
Total	**13**	**88**	**107**	**52**	**43**	**17**	**15**	**15**	**10**	**23**	**383**

Table 4.4.4 The weight (in gram) of large tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

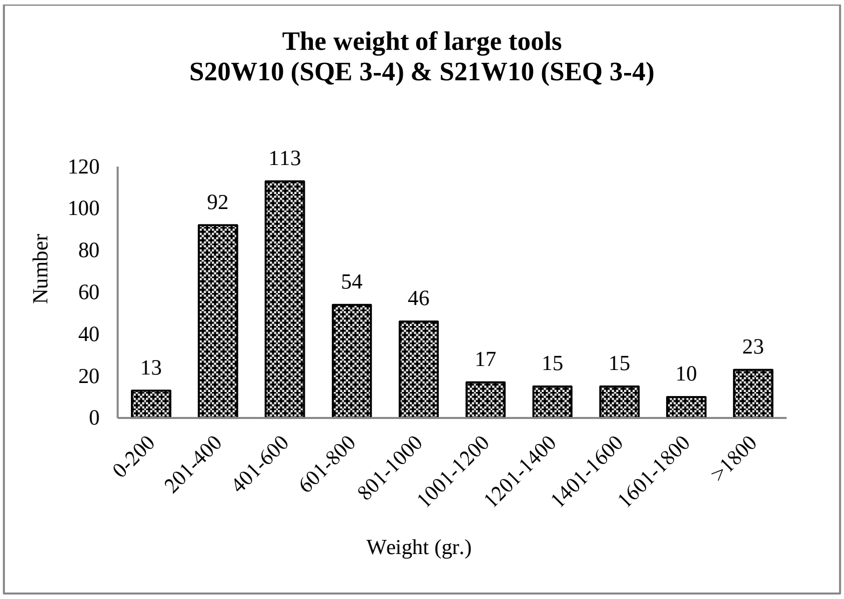


Figure 4.4.3 Distribution of the weight (gr.) of large tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The large tools have been found to vary within a large range of weights, from less than 200 to more than 1800 g, but most of them (80%) weight between 201 and 1000 g, with a concentration between 401 and 600 g, especially in the upper layers **(figure 4.4.3)**.

4.4.2 Choppers

The choppers are large tools (all of them are measuring more than 10 cm), and represent about 32% (254/794) in the total of all tools from stratigraphic layers 3 to 10 of area 2 sectors 20W10 and S21W10. Three main categories of choppers are distinguished in this chopper group: end chopper, side chopper and other choppers. The most significant other choppers are: corner choppers, double choppers, multiple choppers, extended choppers, giant choppers, pointed choppers, nosed choppers, denticulated choppers, and steep choppers (horse-hoof). Out of these, there are 102 end choppers, 56 side choppers and 96 other choppers **(Table 4.4.2.1, figure 4.4.2.1)**.

Choppers **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Layer 3**		**Layer 4**		**Layer 5**		**Layer 6**		**Layer 7**		**Layer 8**		**Layer 9**		**Layer 10**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
End chopper	**40**	47	**12**	37	**3**		**3**		**20**	65	**8**	17	**13**	45	**3**		**102** (40)
Side chopper	**13**	15	**12**	36	**2**		**2**		**3**		**17**	35	**6**	21	**1**		**56** (22)
Multiple chopper	**5**	6	**0**		**0**		**1**		**6**	19	**4**		**2**		**0**		**18** (7)
Double chopper	**13**	15	**3**		**0**		**1**		**1**		**5**	10	**1**		**1**		**25** (10)
Corner chopper	**3**		**2**		**0**		**0**		**1**		**5**	10	**1**		**0**		**12** (5)
Steep chopper	**4**		**0**		**0**		**0**		**0**		**2**		**0**		**0**		**6** (2)
Pointed chopper	**1**		**1**		**0**		**3**		**0**		**3**		**0**		**3**		**11** (4)
Denticulated chopper	**2**		**2**		**0**		**0**		**0**		**4**		**1**		**0**		**9** (4)
Extended chopper	**0**		**1**		**0**		**0**		**0**		**1**		**4**		**1**		**7** (3)
Nosed chopper	**0**		**0**		**0**		**0**		**0**		**0**		**1**		**1**		**2**
Giant chopper	**5**	6	**0**		**0**		**0**		**0**		**0**		**0**		**1**		**6** (2)
Total	**86**	34	**33**	13	**5**	2	**10**	4	**31**	12	**49**	19	**29**	12	**11**	4	**254**
Large tools **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**138**		**79**		**7**		**14**		**38**		**60**		**36**		**11**		**383**

Table 4.4.2.1 The different types of choppers in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

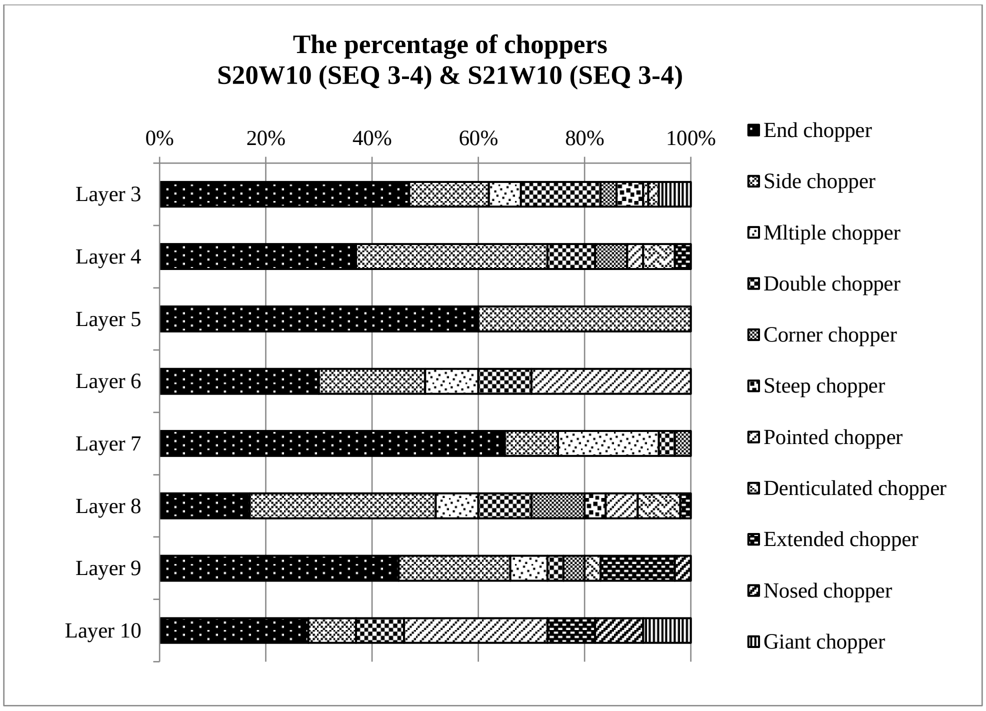


Figure 4.4.2.1 Distribution the different types of choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Raw materials **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Gray sandstone**		**Black sandstone**		**Mudstone**		**Quartzite**		**Siliceous shale**		**Andesite**		**Quartz**		**Total**
Layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3	**80**	93	**4**		**1**		**1**		**0**		**0**		**0**		**86**
Layer 4	**30**	91	**2**		**0**		**1**		**0**		**0**		**0**		**33**
Layer 5	**5**	100	**0**		**0**		**0**		**0**		**0**		**0**		**5**
Layer 6	**9**	90	**1**		**0**		**0**		**0**		**0**		**0**		**10**
Layer 7	**29**	94	**2**		**0**		**0**		**0**		**0**		**0**		**31**
Layer 8	**43**	88	**2**		**0**		**2**		**1**		**1**		**0**		**49**
Layer 9	**27**	93	**1**		**0**		**1**		**0**		**0**		**0**		**29**
Layer 10	**9**	82	**0**		**0**		**1**		**0**		**0**		**1**		**11**
Total	**232**	91	**12**	5	**1**	1	**6**	2	**1**	1	**1**	0	**1**	0	**254**

Table 4.4.2.2 The raw materials of choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

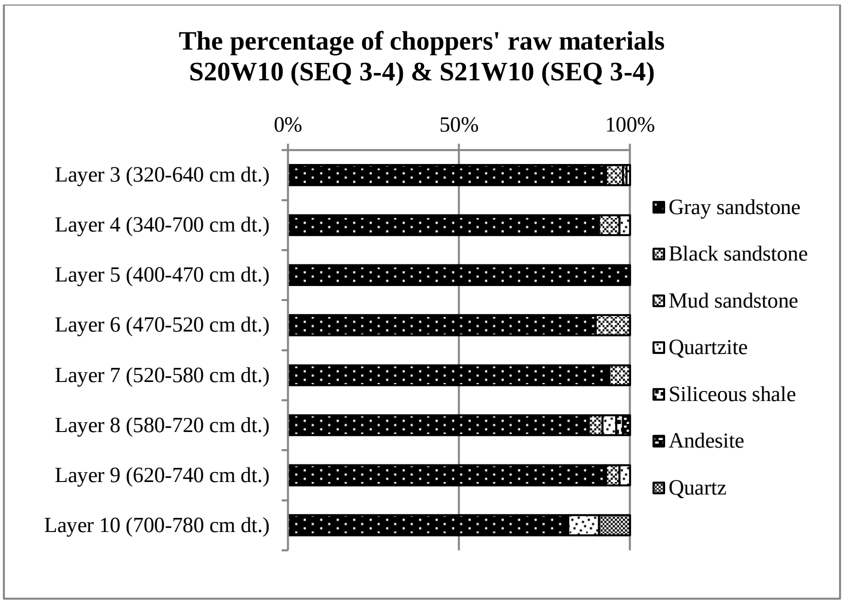


Figure 4.4.2.2 Distribution the raw materials of choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The main raw material is the gray sandstone, providing 91% of the studied choppers. This proportion is quite similar in the different layers (more than 80%), but numbers are very small in the layers 5, 6 and 10 (less than 10 artefacts).

The other raw materials such as black sandstone, mudstone, quartzite and siliceous shale are barely represented in these sectors **(Table 4.4.2.2)**.

Weight (gr.) **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**<200**	**201-400**	**401-600**	**601-800**	**801-1000**	**1001-1200**	**1201-1400**	**1401-1600**	**1601-1800**	**>1801**	**Total**
Layer 3	6	15	13	12	14	1	7	5	1	12	**86**
Layer 4	0	7	11	8	2	2	0	1	0	2	**33**
Layer 5	2	0	0	0	0	0	1	0	0	2	**5**
Layer 6	0	1	3	1	2	0	1	0	0	2	**10**
Layer 7	1	6	7	3	4	4	1	1	1	3	**31**
Layer 8	0	11	11	4	9	4	3	3	2	2	**49**
Layer 9	0	6	5	8	4	3	0	2	1	0	**29**
Layer 10	0	1	1	3	2	1	0	2	0	1	**11**
Total	**9**	**47**	**51**	**39**	**37**	**15**	**13**	**14**	**5**	**24**	**254**

Table 4.4.2.3 The weight (in gram) of choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

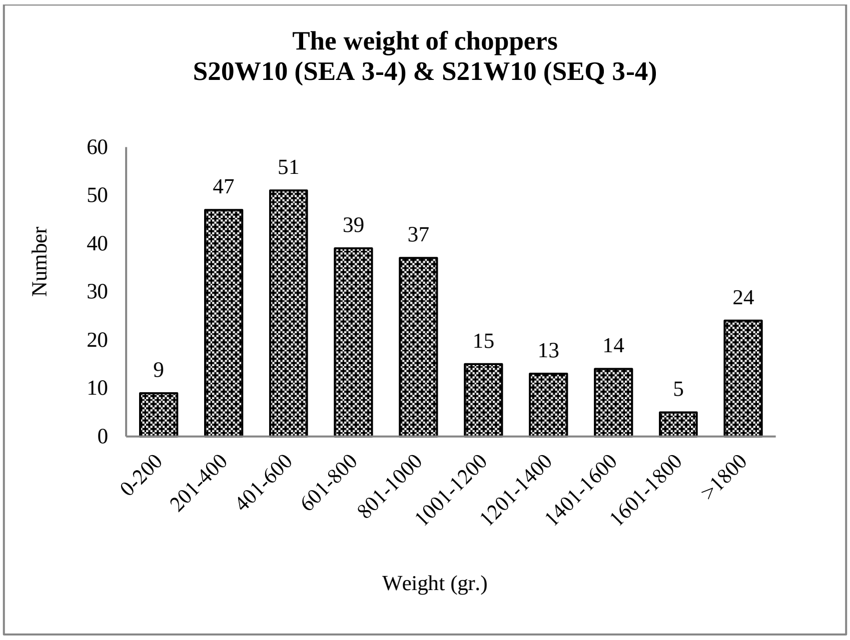


Figure 4.4.2.3 Distribution of the weight (in gram) of choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The weight classes of most choppers are diversified from 201 to 1000 g, but, they are wealthy between 201 and 400 g, mainly in the upper layers 3 to 4, besides in the layer 8 of these sectors **(figure 4.4.2.3)**.

4.4.2.1 End choppers

1) General features of the end choppers

There are many end choppers among the large tools, 27% (102/383) from the stratigraphic layers 3 to 10 of area 2 sectors S20W10 and S21W10. The end choppers are hardly represented in the sectors. It is to be note that the layer 3 of sector S20W10 is highly present nearly 40 specimens **(Table 4.4.2.1.1)**.

The most important percentage is in the layer 7 (53%: 20/38) and after that in the layers 9 and 5, with about 36-34%. In the other layers, they are not representative in the proportions, with the exception of the layers 3 and 10 (29-27%).

End choppers	**Layer 2**		**Layer 3**		**Layer 4**		**Layer 5**		**Layer 6**		**Layer 7**		**Layer 8**		**Layer 9**		**Layer 10**		**Total**
Numbers (%)	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
S20W10 (SEQ 3-4)	**3**		**39**	30	**10**	14	**0**		**0**		**0**		**5**	13	**1**		**2**		**60**
S21W10 (SEQ 3-4)	**1**		**1**		**2**		**3**		**3**		**20**	53	**3**		**12**	55	**1**		**46**
S21W10 (SEQ 1-2)	**-**		**-**		**-**		**1**		**12**	43	**1**		**-**		**-**		**-**		**14**
S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**4**		**40**	29	**12**	15	**3**		**3**		**20**	53	**8**	13	**13**	36	**3**		**102**(27%)
Large tools S20W10 (SEQ3-4) & S21W10 (SEQ 3-4)	**15**		**138**		**79**		**7**		**14**		**38**		**60**		**36**		**11**		**383**

Table 4.4.2.1.1 Total number of end choppers in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4), S21W10 (SEQ 3-4) and S21W10 (SEQ 1-2)

Raw materials **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Gray sandstone**		**Black sandstone**		**Quartzite**		**Total**
Layer 3 (320-640 cm dt.)	**39**	97	**0**		**1**		**40**
Layer 4 (340-700 cm dt.)	**10**	83	**2**		**0**		**12**
Layer 5 (400-470 cm dt.)	**3**		**0**		**0**		**3**
Layer 6 (470- 520 cm dt.)	**3**		**0**		**0**		**3**
Layer 7 (520- 580 cm dt.)	**18**	90	**2**		**0**		**20**
Layer 8 (580-720 cm dt.)	**8**	100	**0**		**0**		**8**
Layer 9 (620-740 cm dt.)	**13**	100	**0**		**0**		**13**
Layer 10 (700-780 cm dt.)	**2**		**0**		**1**		**3**
Total	**96**	94	**4**	4	**2**	2	**102**

Table 4.4.2.1.2 The raw materials of end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The large majority of the end choppers are in gray sandstone, in all the layers, making up about 94% (96/102) of them. The black sandstone and quartzite are rarely found in these sectors **(Table 4.4.2.1.2)**.

2) Measurements

Measurement S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Length (mm)**	**Width (mm)**	**Thickness (mm)**	**Number of end choppers**
Layer 3 (320-640 cm dt.)	133	90	57	40
Layer 4 (340-700 cm dt.)	130	84	52	12
Layer 5 (400-470 cm dt.)	144	101	60	3
Layer 6 (470- 520 cm dt.)	122	67	54	3
Layer 7 (520- 580 cm dt.)	136	95	50	20
Layer 8 (580-720 cm dt.)	133	100	60	8
Layer 9 (620-740 cm dt.)	136	94	61	13
Layer 10 (700-780 cm dt.)	127	78	52	3
Average	**134**	**91**	**55**	**102**

Table 4.4.2.1.3 Average dimensions of end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The average measurements of the end choppers are quite similar in all the layers, if layers 5 and 6 which only yielded 3 end choppers each are considered together. The length is around 130-135 mm, except in the lowest layer 10 where it is slightly less (127 mm) but where there are only 3 end choppers. The width varies in a wider range, between 80 and 100 mm. The average thickness is around 55 mm and it is somewhat similar in all layers **(Table 4.4.2.1.3, figures 4.4.2.1.4 & 4.4.2.1.5)**.

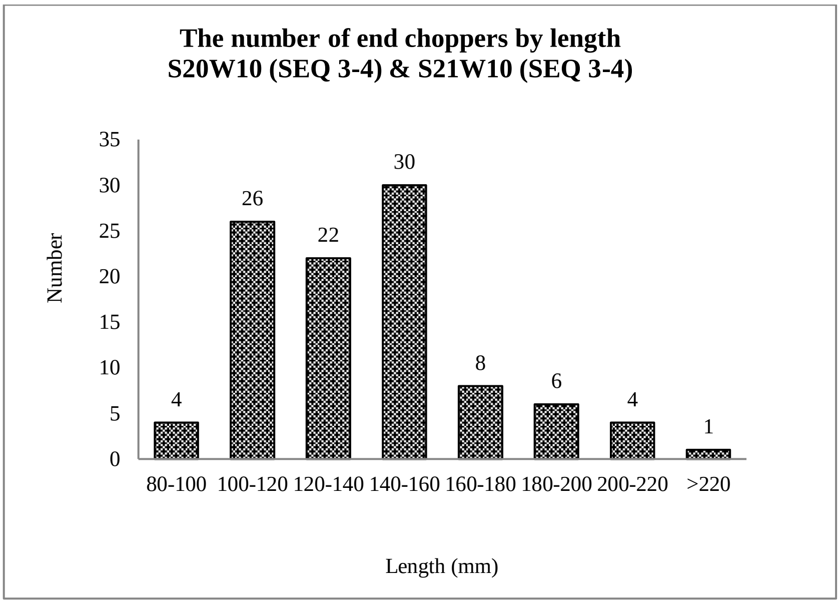


Figure 4.4.2.1.1 Distribution of the end choppers by length from Tham Lod Rockshelter area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

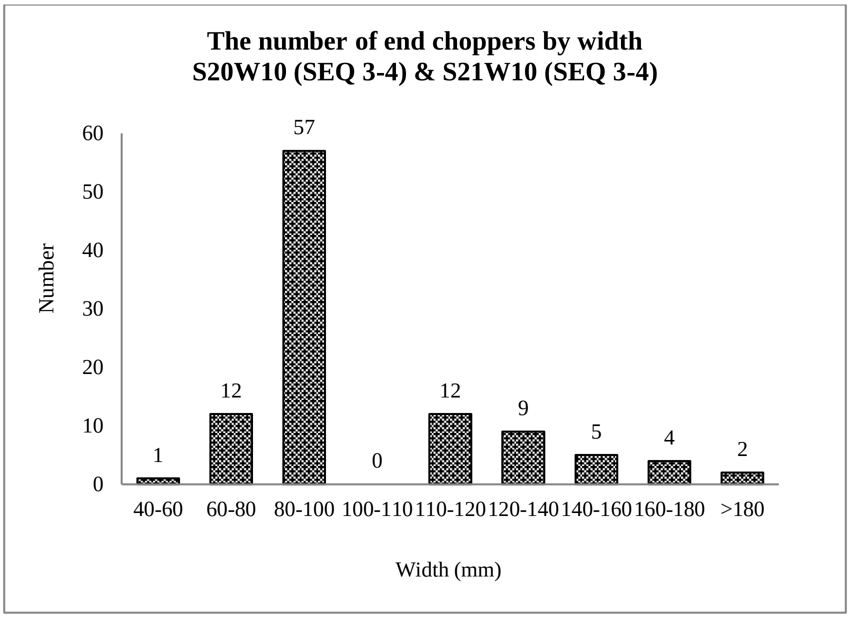


Figure 4.4.2.1.2 Distribution of the end choppers by width from Tham Lod Rockshelter area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

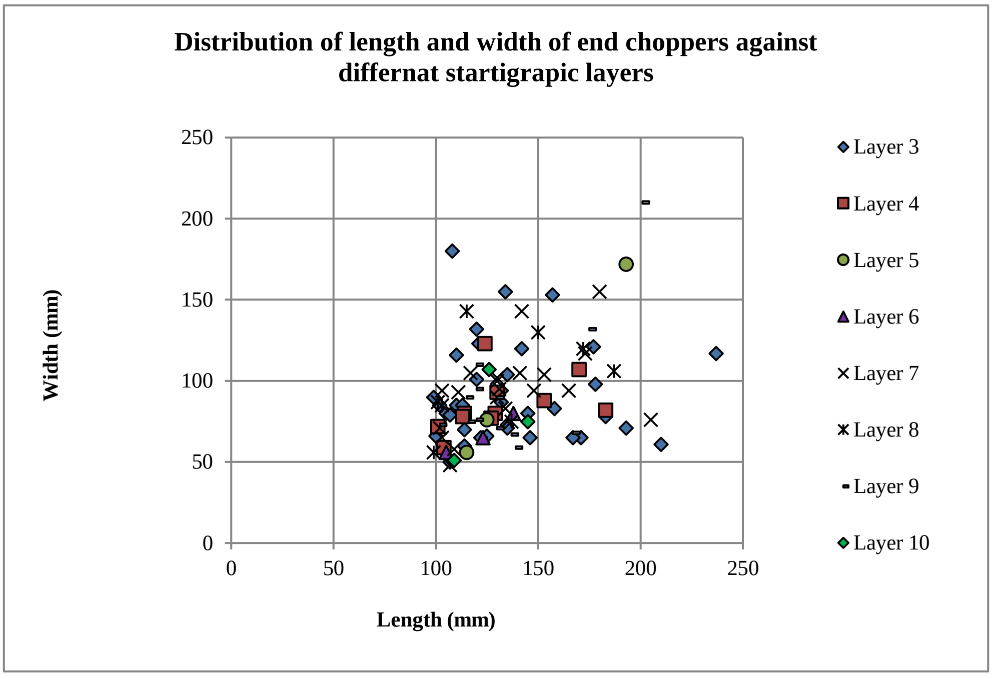


Figure 4.4.2.1.3 Scatter diagram length x width of the end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The length and the width of the end choppers both show a bimodal distribution suggesting two groups among this tool type: a group of smaller tools, less than 120-130 mm long and less than 100 mm wide and a group of larger tools **(figure 4.4.2.1.3)**.

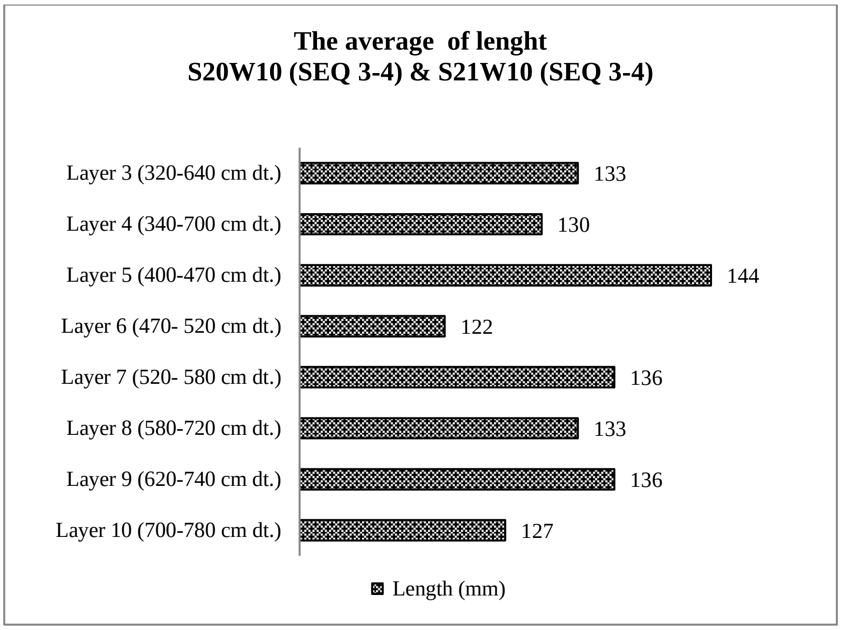


Figure 4.4.2.1.4 Distribution of the average length of the end choppers across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

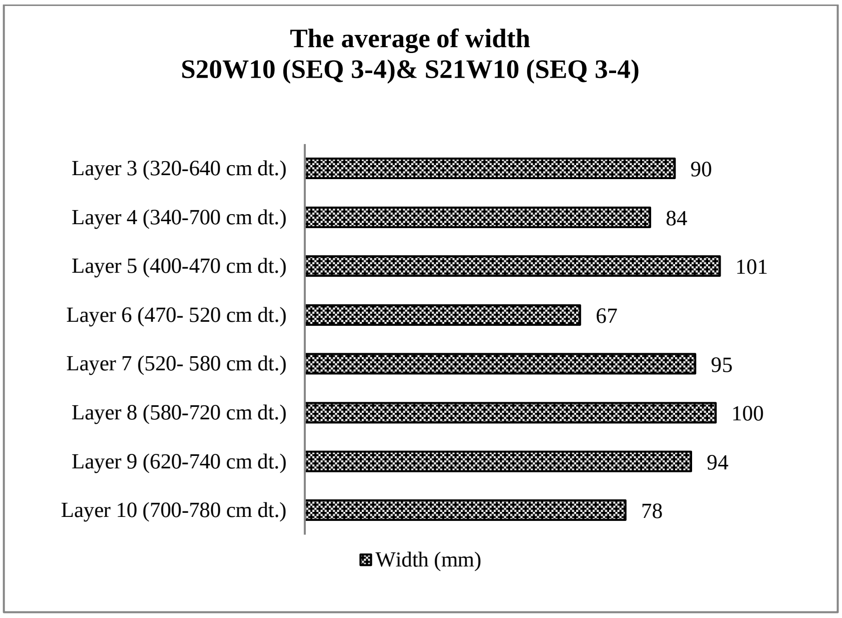


Figure 4.4.2.1.5 Distribution of the average width of the end choppers across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Weight (gr.) **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**<200**	**201-400**	**401-600**	**601-800**	**801-1000**	**1001-1200**	**1201-1400**	**1401-1600**	**1601-1800**	**>1800**	**Total**
Layer 3	2	7	5	5	9	0	5	2	0	5	**40**
Layer 4	0	3	2	3	1	1	0	0	0	2	**12**
Layer 5	0	0	3	0	0	0	0	0	0	0	**3**
Layer 6	0	0	1	1	0	0	1	0	0	0	**3**
Layer 7	2	3	3	1	3	2	2	0	0	4	**20**
Layer 8	0	2	1	0	2	0	0	0	1	2	**8**
Layer 9	1	2	4	3	1	0	1	0	1	0	**13**
Layer 10	0	0	0	0	0	1	0	1	0	1	**3**
Total	**5**	**17**	**19**	**13**	**16**	**4**	**9**	**3**	**2**	**14**	**102**

Table 4.4.2.1.4 The weight (in gram) of end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ3-4) & S21W10 (SEQ 3-4)

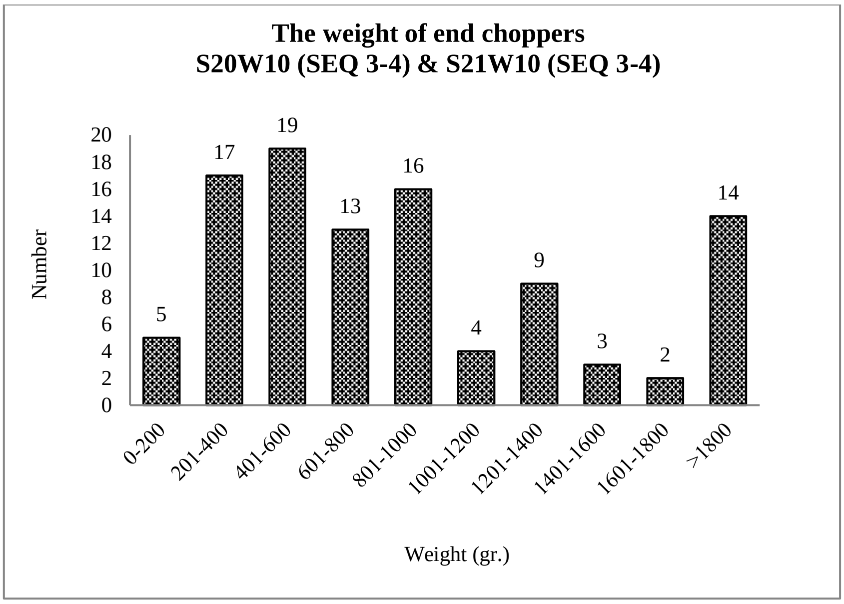


Figure 4.4.2.1.6 Distribution of the weight (in gram) of end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The weight of the end choppers ranges from less than 200 to more than 1800 g. The maximum weight is in the layer 10 (5700 g). Most of end choppers are weighing between 201 and 1000 g (70 tools: nearly 65%), mainly between 801 and 1000 g with 9 specimens found in the layer 3. The other weight classes are very poor but all together the end choppers weighing more than 1 kg represent 30% **(Table 4.4.2.1.4, figure 4.4.2.1.6)**.

3) Supports

The principal supports of the end choppers are broken cobbles and cobble fragments almost 80% (81/102) and much behind, the whole cobbles (12/102: 12%); the other supports like split cobbles, indeterminate cobbles, flakes and fragments are very rare represented (around 10 % in the total) **(Table 4.4.2.1.5, figure 4.4.2.1.7)**.

Supports S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Broken cobble**		**Cobble fragment**		**Whole cobble**		**Split cobble**		**Indeter-minate cobble**		**Flake**		**Fragment**		**Total**
Layers	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N
Layer 3	**14**	35	**18**	45	**3**		**2**		**0**		**2**		**1**		**40**
Layer 4	**6**	50	**5**	42	**1**		**0**		**0**		**0**		**0**		**12**
Layer 5	**1**		**2**		**0**		**0**		**0**		**0**		**0**		**3**
Layer 6	**3**		**0**		**0**		**0**		**0**		**0**		**0**		**3**
Layer 7	**13**	65	**1**		**6**	30	**0**		**0**		**0**		**0**		**20**
Layer 8	**3**		**2**		**2**		**1**		**0**		**0**		**0**		**8**
Layer 9	**11**	84	**0**		**0**		**0**		**1**		**1**		**0**		**13**
Layer 10	**1**		**1**		**0**		**1**		**0**		**0**		**0**		**3**
Total	**52**	51	**29**	28	**12**	12	**4**		**1**		**3**		**1**		**102**

Table 4.4.2.1.5 The supports of end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

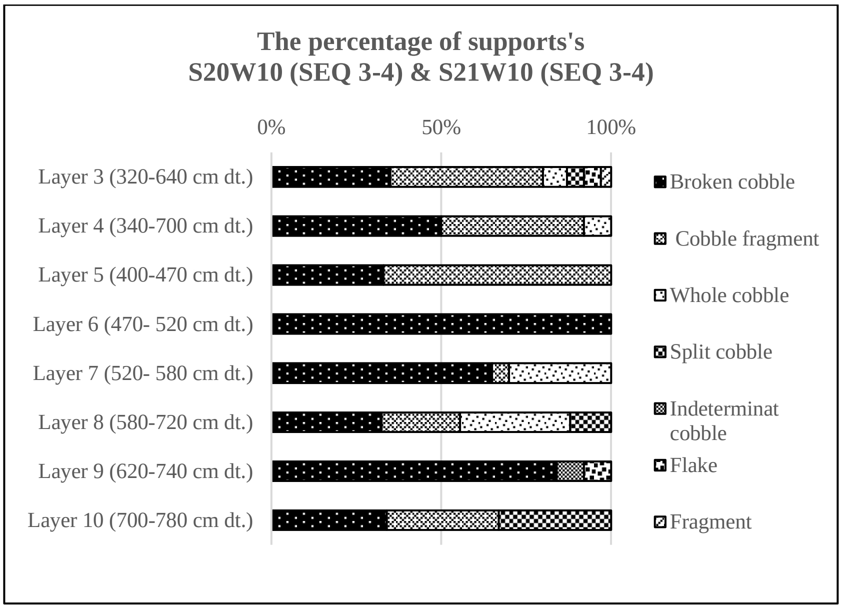


Figure 4.4.2.1.7 Distribution of the supports of end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4) General morphology of end choppers

4.1) Frontal view

Frontal view **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Irregular**		**Oval**		**Trape-zoidal**		**Triangular**		**Half-oval**		**D-shape**		**Pentagonal**		**Circular**		**Convex-concave**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**9**	22	**11**	27	**12**	30	**4**		**0**		**2**		**1**		**0**		**1**		**40**
Layer 4 (340-700 cm dt.)	**5**	41	**3**		**2**		**2**		**0**		**0**		**0**		**0**		**0**		**12**
Layer 5 (400-470 cm dt.)	**0**		**2**		**0**		**0**		**1**		**0**		**0**		**0**		**0**		**3**
Layer 6 (470- 520 cm dt.)	**0**		**0**		**1**		**0**		**0**		**1**		**0**		**1**		**0**		**3**
Layer 7 (520- 580 cm dt.)	**9**		**4**		**1**		**3**		**0**		**0**		**2**		**1**		**0**		**20**
Layer 8 (580-720 cm dt.)	**1**		**3**		**3**		**0**		**0**		**1**		**0**		**0**		**0**		**8**
Layer 9 (620-740 cm dt.)	**4**		**4**		**0**		**0**		**5**	38	**0**		**0**		**0**		**0**		**13**
Layer 10 (700-780 cm dt.)	**0**		**1**		**1**		**0**		**0**		**0**		**1**		**0**		**0**		**3**
Total	**28**	27	**28**	27	**20**	20	**9**	9	**6**	6	**4**	4/102	**4**	4/102	**2**		**1**		**102**

Table 4.4.2.1.6 The frontal view of end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4.2) Transversal view

Transversal view **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Oval**		**Irregular**		**Trapezoidal**		**Triangular**		**Half-oval**		**D-shape**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**8**	20	**3**		**15**	38	**9**	23	**4**	9	**1**		**40**
Layer 4 (340-700 cm dt.)	**2**		**3**		**3**		**0**		**3**		**1**		**12**
Layer 5 (400-470 cm dt.)	**0**		**0**		**0**		**0**		**3**		**0**		**3**
Layer 6 (470- 520 cm dt.)	**0**		**3**		**0**		**0**		**0**		**0**		**3**
Layer 7 (520- 580 cm dt.)	**1**		**19**	95	**0**		**0**		**0**		**0**		**20**
Layer 8 (580-720 cm dt.)	**4**		**0**		**1**		**2**		**0**		**1**		**8**
Layer 9 (620-740 cm dt.)	**12**	92	**0**		**1**		**0**		**0**		**0**		**13**
Layer 10 (700-780 cm dt.)	**2**		**0**		**1**		**0**		**0**		**0**		**3**
Total	**29**	28	**28**	27	**21**	21	**11**	11	**10**	10	**3**	3/102	**102**

Table 4.4.2.1.7 The transversal view of end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

In the frontal view, besides irregular shapes (28/102: 27%), the oval shape is more frequent (28/102: 27%), as expected for tools made from cobbles **(Table 4.4.2.1.6)**. For the same reason the transversal view is often oval (29/102: 28%) but the trapezoidal or triangular shapes are yet noticeable (20% and 11% respectively) apart from the irregular shapes (28/102: 27%) especially frequent in the layers 6 and 7 **(Table 4.4.2.1.7)**.

5) Shaping of the end choppers

5.1) Amount of cortex

- On the upper face

Amount of cortex S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**27**	67	**10**	25	**3**		**40**
Layer 4 (340-700 cm dt.)	**6**	50	**4**		**2**		**12**
Layer 5 (400-470 cm dt.)	**3**		**0**		**0**		**3**
Layer 6 (470- 520 cm dt.)	**1**		**1**		**1**		**3**
Layer 7 (520- 580 cm dt.)	**12**	60	**4**		**4**		**20**
Layer 8 (580-720 cm dt.)	**7**	87	**1**		**0**		**8**
Layer 9 (620-740 cm dt.)	**6**	46	**4**		**3**		**13**
Layer 10 (700-780 cm dt.)	**1**		**2**		**0**		**3**
Total	**63**	62	**26**	25	**13**	13	**102**

Table 4.4.2.1.8 Amount of cortex on upper face of the end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

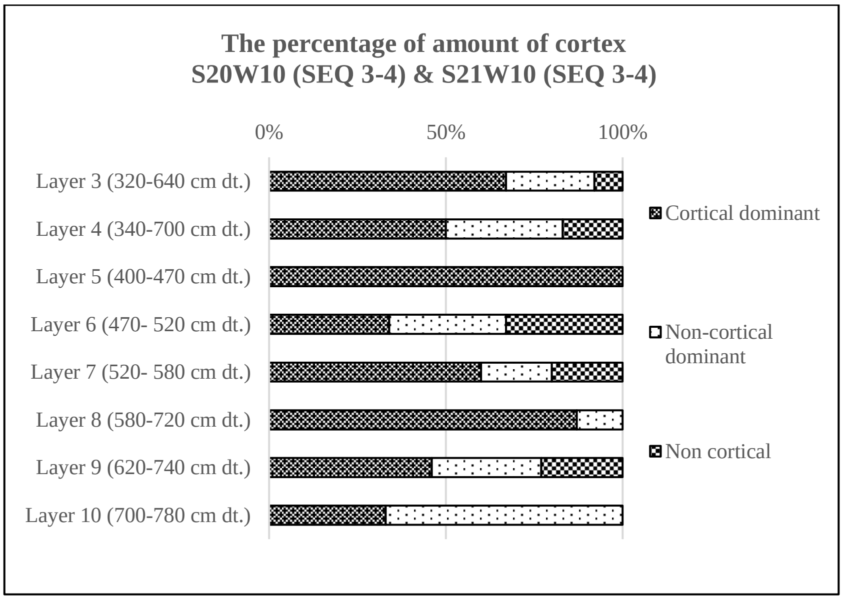


Figure 4.4.2.1.8 Distribution of the amount of cortex on the upper face of end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The upper face of the end choppers is mostly "cortical dominant" (63/102: 62%), especially in the layer 8; then it is "non-cortical dominant" (26/102: 25%). Absence of cortex on the upper face is not negligible in the layers 9 and 7 (3/13 and 4/20 respectively) **(Table 4.4.2.1.8, figure 4.4.2.1.8)**

- *On the lower face*

Amount of cortex **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Totally cortical**		**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**18**	45	**11**	27	**3**		**8**	20	**40**
Layer 4 (340-700 cm dt.)	**5**	42	**7**	58	**0**		**0**		**12**
Layer 5 (400-470 cm dt.)	**2**		**1**		**0**		**0**		**3**
Layer 6 (470- 520 cm dt.)	**1**		**2**		**0**		**0**		**3**
Layer 7 (520- 580 cm dt.)	**15**	75	**3**		**0**		**2**		**20**
Layer 8 (580-720 cm dt.)	**7**	87	**0**		**0**		**1**		**8**
Layer 9 (620-740 cm dt.)	**7**	54	**4**		**1**		**1**		**13**
Layer 10 (700-780 cm dt.)	**2**		**0**		**0**		**1**		**3**
Total	**57**	56	**28**	27	**4**		**13**		**102**

Table 4.4.2.1.9 Amount of cortex on lower face of the end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

About half 56% (57/102) of end choppers are "totally cortical" on the lower face. This is especially marked in the layer 8: 87% and layer 7: 75% and the lowest value is in the layer 6 (33%), but it is very poor. After that, the "cortical dominant" is quite variable in the layers and the most significant is in the layers 6 and 4 (67-58%). The "non-cortical" and "non-cortical dominant" is rarely represented, except in the layer 10 for the "non-cortical", where it is about 33% **(Table 4.4.2.1.9)**.

5.2) Number of removals (shaping the tools)

- On the upper face

Number of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**>10 (~12)**	Total number of end choppers	Total number of removals	Average number of removals (total number of removals / total number of tools)
Layer 3	7	7	9	6	7	1	1	1	0	1	0	**40**	**129**	3,2
Layer 4	2	5	1	1	2	0	0	1	0	0	0	**12**	**37**	3,1
Layer 5	0	1	2	0	0	0	0	0	0	0	0	**3**	**8**	2,7
Layer 6	0	0	1	0	1	0	0	0	0	0	1	**3**	**20**	6,7
Layer 7	1	2	3	2	1	3	1	0	1	0	6	**20**	**133**	6,7
Layer 8	3	2	1	0	0	1	0	0	1	0	0	**8**	**25**	3,1
Layer 9	3	1	2	2	1	2	2	0	0	0	0	**13**	**50**	3,8
Layer 10	1	0	0	0	1	0	0	0	0	0	1	**3**	**18**	6,0
Total	**17**	**18**	**19**	**11**	**13**	**7**	**4**	**2**	**2**	**1**	**8**	**102**	**420**	4,1

Table 4.4.2.1.10 Number of removals on upper face of the end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The 3 and 2 removals are rather constant in these sectors, representing 18 and 17% of the studied end choppers. Shaping by 3 removals mainly occurs in the layers 3 and then the 2 removals is more significant in the layer 4 (50%) **(Table 4.4.2.1.10)**. It appears that the average number of removals shaping the end choppers is more in the middle layers 6 to 7.

- On the lower face

Number of removals S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	1	2	3	4	Total number of end choppers with removals on the lower face	Total number of removals	Average number of removals (total number of removals / total number of tools)
Layer 3 (320-640 cm dt.)	2	4	0	2	**8**	**18**	2,2
Layer 6 (470- 520 cm dt.)	0	0	0	1	**1**	**4**	4,0
Layer 7 (520- 580 cm dt.)	2	0	1	1	**4**	**9**	2,2
Layer 9 (620-740 cm dt.)	1	1	0	0	**2**	**3**	1,5
Total	**5**	**5**	**1**	**4**	**15**	**34**	2,3

Table 4.4.2.1.11 Number of removals on lower face of the end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Nearly 15% (15/102) of the end choppers also bear some removals on their lower face. In most of the cases one or two removals occur on the lower face, rarely more and never more than 4 removals (**Table 4.4.2.1.11**).

5.3) Direction of removals

- On the upper face

Direction of removals S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Unipolar**		**Bipolar-opposite**		**Bidirectional-orthogonal**		**Three-directions**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**32**	80	**7**	17	**1**		**0**		**40**
Layer 4 (340-700 cm dt.)	**10**	83	**1**		**1**		**0**		**12**
Layer 5 (400-470 cm dt.)	**2**		**1**		**0**		**0**		**3**
Layer 6 (470- 520 cm dt.)	**2**		**0**		**0**		**1**		**3**
Layer 7 (520- 580 cm dt.)	**9**	45	**4**		**5**	25	**2**		**20**
Layer 8 (580-720 cm dt.)	**8**	100	**0**		**0**		**0**		**8**
Layer 9 (620-740 cm dt.)	**9**	69	**2**		**2**		**0**		**13**
Layer 10 (700-780 cm dt.)	**1**		**0**		**1**		**1**		**3**
Total	**73**	71	**15**	15	**10**	10	**4**		**102**

Table 4.4.2.1.12 Direction of removals on upper face of the end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

- On the lower face

Direction of removals S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Unipolar**		**Bipolar-opposite**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**7**	87	**1**		**8**
Layer 6 (470- 520 cm dt.)	**1**		**1**		**2**
Layer 7 (520- 580 cm dt.)	**2**		**1**		**3**
Layer 9 (620-740 cm dt.)	**2**		**0**		**2**
Total	**12**	80	**3**		**15**

Table 4.4.2.1.13 Direction of removals on lower face of the end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The end choppers are expected to be shaped by unipolar unidirectional removals and at Tham Lod, around 70% of them fit to this pattern (73/102: 73%). This is especially the case in the upper layers 4 to 3 and also in the layer 8. The other patterns of removals such as “bipolar-opposite”, “bidirectional-orthogonal” and “three-direction” correspond to end choppers whose shaping is slightly extending on other sides else than just the end **(Table 4.4.2.1.12)**. On the lower face of the end choppers, the “unipolar” pattern is usually observed (12/15: 80%) and, on two tools only, the “bipolar-opposite” pattern too **(Table 4.4.2.1.13)**.

5.4) Length of the longest removal

- On the upper face

Longest removal S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**10-20**	**21-30**	**31-40**	**41-50**	**51-60**	**61-70**	**71-80**	Total number of end choppers	Average maximal length (mm)
Layer 3 (320-640 cm dt.)	7	6	11	5	4	4	3	**40**	40
Layer 4 (340-700 cm dt.)	1	2	2	7	0	0	0	**12**	39
Layer 5 (400-470 cm dt.)	1	0	0	1	0	1	0	**3**	38
Layer 6 (470- 520 cm dt.)	0	2	0	0	0	0	1	**3**	22
Layer 7 (520- 580 cm dt.)	0	4	8	4	3	1	0	**20**	41
Layer 8 (580-720 cm dt.)	2	2	1	2	1	0	0	**8**	37
Layer 9 (620-740 cm dt.)	1	3	2	1	6	0	0	**13**	43
Layer 10 (700-780 cm dt.)	0	0	0	1	1	0	1	**3**	55
Total	**12**	**19**	**24**	**21**	**15**	**6**	**5**	**102**	

Table 4.4.2.1.14 Length of the longest removal (in mm) on upper face of end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Figure 4.4.2.1.9 Distribution of length (in mm) of the longest removal on upper face of end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The length of the longest removals on the upper face 10-80 mm, varies within a large range of values but shows a regular normal distribution **(figure 4.4.2.1.9)** with an average around 40 mm **(Table 4.4.2.1.14)**.

- *On the lower face*

Longest removal **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**10-20**	**21-30**	**31-40**	**41-50**	Total number of end choppers	Average maximal length
Layer 3 (320-640 cm dt.)	4	3	1	0	**8**	21
Layer 6 (470- 520 cm dt.)	1	0	0	1	**2**	15
Layer 7 (520- 580 cm dt.)	0	3	0	0	**3**	30
Layer 9 (620-740 cm dt.)	0	1	1	0	**2**	27
Total	**5**	**7**	**2**	**1**	**15**	

Table 4.4.2.1.15 Length of the longest removal on lower face of the end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

On the lower face, the longest removal is usually much shorter than on the upper face: they rarely overcome 50 mm and they are mostly confined to less than 30 mm (**Table 4.4.2.1.15**).

5.5) Extent of removals

- On the upper face

Extent of removals S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Marginal**		**Extensive**		**Very extensive**		**Totally invading**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**31**	77	**8**	20	**1**		**0**		**40**
Layer 4 (340-700 cm dt.)	**8**	67	**3**		**1**		**0**		**12**
Layer 5 (400-470 cm dt.)	**3**		**0**		**0**		**0**		**3**
Layer 6 (470- 520 cm dt.)	**0**		**3**		**0**		**0**		**3**
Layer 7 (520- 580 cm dt.)	**10**	50	**7**	35	**0**		**3**		**20**
Layer 8 (580-720 cm dt.)	**6**	75	**2**		**0**		**0**		**8**
Layer 9 (620-740 cm dt.)	**9**	69	**3**		**0**		**1**		**13**
Layer 10 (700-780 cm dt.)	**0**		**2**		**1**		**0**		**3**
Total	**67**	66	**28**	27	**3**		**4**		**102**

Table 4.4.2.1.16 Extent of removals on upper face of end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

- On the lower face

Extent of removals S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Marginal**		**Extensive**		**Total**
Stratigraphic layers	**N**	%	**N**	%	N
Layer 3 (320-640 cm dt.)	**8**	100	**0**		**8**
Layer 6 (470- 520 cm dt.)	**2**		**0**		**2**
Layer 7 (520- 580 cm dt.)	**2**		**1**		**3**
Layer 9 (620-740 cm dt.)	**2**		**0**		**2**
Total	**14**	93	**1**		**15**

Table 4.4.2.1.17 Extent of removals on lower face of the end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The marginal removals are by far the most frequent on the end choppers in these sectors, with about 66% (67/102). The highest percentage is in the layer 5, and they are frequently present in the layers 3 and 8 (77% and 75% respectively). The extensive removals are in the second position, providing 27% (28/102) of the end choppers **(Table 4.4.2.1.16)**.

Almost all the removals occurring on the lower face are just marginal (14/15) and only one end chopper has an invasive removal on the lower face (in layer 7; **Table 4.4.2.1.17**).

6) Morpho-functional features of end choppers: Nature of the edges

6.1) Nature of the lateral edges

Right side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**21**	52	**17**	43	**2**		**40**
Layer 4 (340-700 cm dt.)	**6**	50	**6**	50	**0**		**12**
Layer 5 (400-470 cm dt.)	**1**		**2**		**0**		**3**
Layer 6 (470- 520 cm dt.)	**1**		**1**		**1**		**3**
Layer 7 (520- 580 cm dt.)	**16**	80	**2**		**2**		**20**
Layer 8 (580-720 cm dt.)	**7**	87	**1**		**0**		**8**
Layer 9 (620-740 cm dt.)	**8**	61	**4**		**1**		**13**
Layer 10 (700-780 cm dt.)	**1**		**1**		**1**		**3**
Total	**61**	60	**34**	33	**7**	7	**102**

Left side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**20**	50	**17**	42	**2**		**1**		**40**
Layer 4 (340-700 cm dt.)	**4**		**5**	42	**3**		**0**		**12**
Layer 5 (400-470 cm dt.)	**2**		**1**		**0**		**0**		**3**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**2**		**0**		**3**
Layer 7 (520- 580 cm dt.)	**12**	60	**4**		**4**		**0**		**20**
Layer 8 (580-720 cm dt.)	**5**	62	**3**		**0**		**0**		**8**
Layer 9 (620-740 cm dt.)	**10**	77	**1**		**2**		**0**		**13**
Layer 10 (700-780 cm dt.)	**1**		**1**		**1**		**0**		**3**
Total	**55**	54	**32**	31	**14**	14	**1**		**102**

Table 4.4.2.1.18 Nature of the lateral (right and left) edges of the end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Both lateral edges are similar as far as their nature is concerned. They are often cortical or shaped (maybe not intentionally) by a fracture. Sometimes the end choppers have been removed by moderate shaping on the lateral edges (**Table 4.4.2.1.18**).

6.2) Nature of the distal edge

Distal side S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**2**		**2**		**33**	82	**3**		**40**
Layer 4 (340-700 cm dt.)	**3**		**3**		**6**	50	**0**		**12**
Layer 5 (400-470 cm dt.)	**0**		**0**		**3**		**0**		**3**
Layer 6 (470- 520 cm dt.)	**0**		**0**		**3**		**0**		**3**
Layer 7 (520- 580 cm dt.)	**1**		**1**		**17**	85	**1**		**20**
Layer 8 (580-720 cm dt.)	**1**		**0**		**6**	75	**1**		**8**
Layer 9 (620-740 cm dt.)	**0**		**0**		**12**	9	**1**		**13**
Layer 10 (700-780 cm dt.)	**0**		**0**		**3**		**0**		**3**
Total	**7**	7	**6**	6	**83**	81	**6**	6	**102**

Table 4.4.2.1.19 Nature of the distal edge of the end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The distal edge of the end choppers is unifacially shaped in most of the cases (2/3); a few tools also are bifacially shaped (6/102)

6.3) Nature of the proximal edge

Proximal side S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**16**	40	**19**	47	**4**		**1**		**40**
Layer 4 (340-700 cm dt.)	**4**		**2**		**6**	50	**0**		**12**
Layer 5 (400-470 cm dt.)	**1**		**2**		**0**		**0**		**3**
Layer 6 (470- 520 cm dt.)	**2**		**0**		**1**		**0**		**3**
Layer 7 (520- 580 cm dt.)	**11**	55	**3**		**3**		**3**		**20**
Layer 8 (580-720 cm dt.)	**5**	62	**2**		**1**		**0**		**8**
Layer 9 (620-740 cm dt.)	**9**	69	**3**		**1**		**0**		**13**
Layer 10 (700-780 cm dt.)	**1**		**1**		**1**		**0**		**3**
Total	**49**	48	**32**	31	**17**	17	**4**	4	**102**

Table 4.4.2.1.20 Nature of the proximal edge of the end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

In general, the proximal edges are mostly cortical or in the form of a fracture, but in the middle layers and in the layer 4, nearly half of the end choppers are shaped on the proximal, widest side (**Table 4.4.2.1.20**).

7) Morpho-functional features of end choppers: Angle of the edges

7.1) Angle of right and left edges

Right side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	N
Layer 3 (320-640 cm dt.)	**7**	17	**12**	30	**12**	30	**9**	23	40
Layer 4 (340-700 cm dt.)	**1**		**2**		**4**		**5**	42	12
Layer 5 (400-470 cm dt.)	**0**		**0**		**2**		**1**		3
Layer 6 (470- 520 cm dt.)	**0**		**1**		**0**		**2**		3
Layer 7 (520- 580 cm dt.)	**3**		**9**	45	**4**		**4**		20
Layer 8 (580-720 cm dt.)	**4**		**1**		**2**		**1**		8
Layer 9 (620-740 cm dt.)	**4**		**2**		**3**		**4**		13
Layer 10 (700-780 cm dt.)	**0**		**2**		**1**		**0**		3
Total	**19**	19	**29**	28	**28**	27	**26**	26	102

Left side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**12**	37	**15**	23	**9**	10	**40**
Layer 4 (340-700 cm dt.)	**1**		**5**	33	**4**		**2**		**12**
Layer 5 (400-470 cm dt.)	**1**		**0**		**1**		**1**		**3**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**0**		**2**		**3**
Layer 7 (520- 580 cm dt.)	**5**	25	**5**	25	**6**	30	**4**		**20**
Layer 8 (580-720 cm dt.)	**2**		**3**		**2**		**1**		**8**
Layer 9 (620-740 cm dt.)	**0**		**4**		**5**	38	**4**		**13**
Layer 10 (700-780 cm dt.)	**0**		**0**		**2**		**1**		**3**
Total	**14**	14	**29**	28	**35**	34	**24**	24	**102**

Table 4.4.2.1.21 Angle of the right and left edges of the end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The left and right edges of the end choppers have the same shapes. They are mostly steep or steep-inverse as expected for cortical sides. Sometimes they are oblique (medium-angled) and rarely acute, in relation with lateral fractures (**Table 4.4.2.1.21)**.

7.2) Angle of distal edge

Distal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**15**	37	**13**	32	**9**	23	**3**		**40**
Layer 4 (340-700 cm dt.)	**4**		**2**		**5**	42	**1**		**12**
Layer 5 (400-470 cm dt.)	**0**		**2**		**1**		**0**		**3**
Layer 6 (470- 520 cm dt.)	**2**		**1**		**0**		**0**		**3**
Layer 7 (520- 580 cm dt.)	**7**		**9**	45	**3**		**1**		**20**
Layer 8 (580-720 cm dt.)	**4**		**3**		**1**		**0**		**8**
Layer 9 (620-740 cm dt.)	**6**	46	**7**	54	**0**		**0**		**13**
Layer 10 (700-780 cm dt.)	**1**		**1**		**1**		**0**		**3**
Total	**39**	38	**38**	37	**20**	20	**5**	5	**102**

Table 4.4.2.1.22 Angle of distal edge of the end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The distal edge of the end choppers is the shaped edge and therefore it is expected to be sharper than the other edges. This is actually the case as the majority of these tools (about 75% in all the layers) have an acute or oblique distal edge. However, there are also steep edges among these end choppers: about 20% (**Table 4.4.2.1.22**).

7.3) Angle of proximal edge

Proximal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**6**	15	**8**	20	**17**	42	**9**	23	**40**
Layer 4 (340-700 cm dt.)	**1**		**4**		**4**		**3**		**12**
Layer 5 (400-470 cm dt.)	**0**		**0**		**1**		**2**		**3**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**1**		**1**		**3**
Layer 7 (520- 580 cm dt.)	**0**		**8**	40	**5**	25	**7**	35	**20**
Layer 8 (580-720 cm dt.)	**3**		**3**		**2**		**0**		**8**
Layer 9 (620-740 cm dt.)	**1**		**3**		**3**		**6**		**13**
Layer 10 (700-780 cm dt.)	**0**		**0**		**3**		**0**		**3**
Total	**12**	12	**26**	26	**36**	35	**28**	27	**102**

Table 4.4.2.1.23 Angle of proximal edge of the end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Opposite to their shaped edge, the end choppers usually have a steep or steep-inverse butt (proximal side). This morphology is even more frequent on the butt (2/3 of the end choppers) than on the lateral edges (**Table 4.4.2.1.23)**.

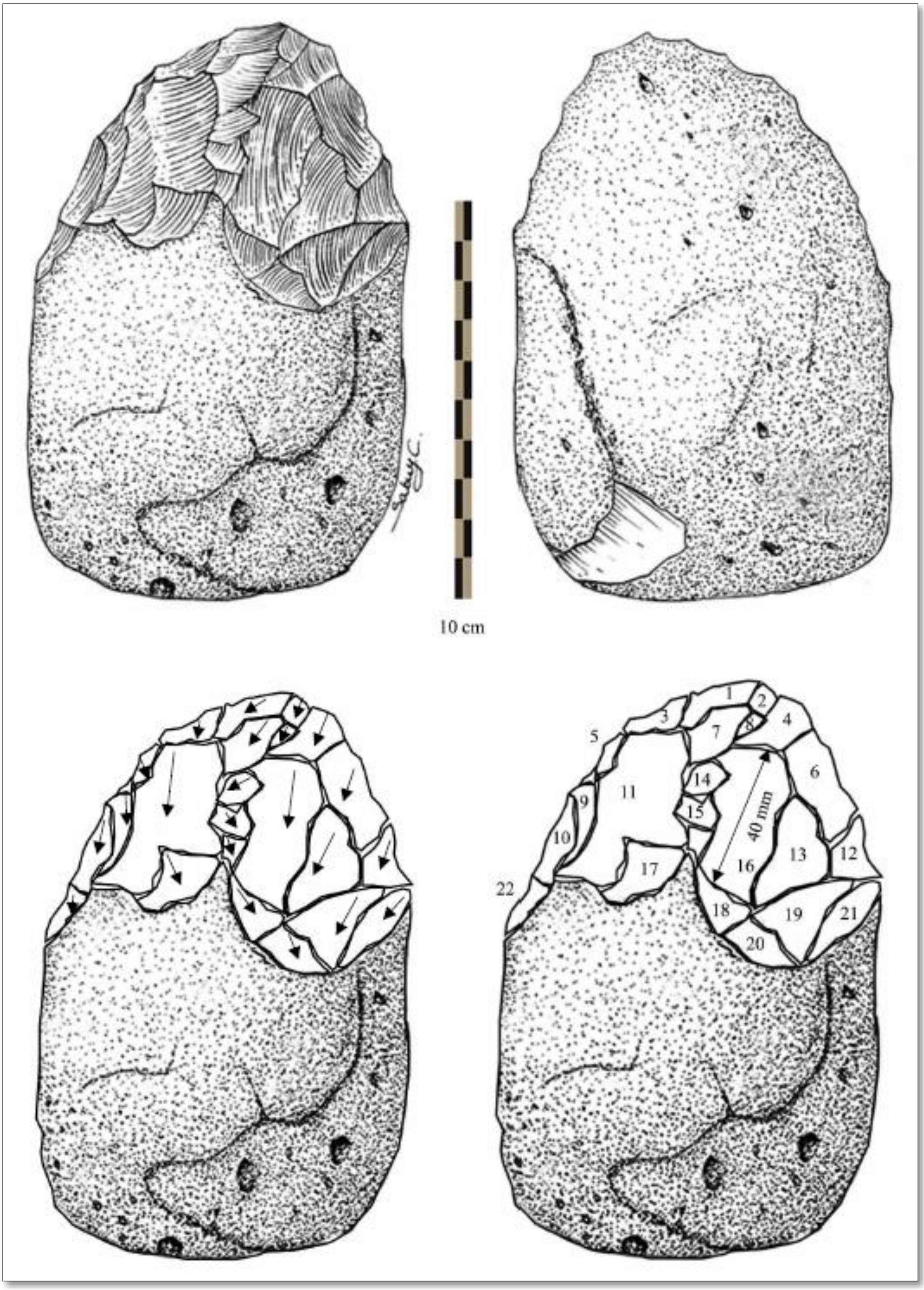


Figure 4.4.2.1.10 Main form of end chopper found at Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4); showing the direction and number of removals and retouches (drawings T. Chitkament)

4.4.2.2 Side choppers

The attributes of the side choppers are rather identical to those of the end choppers, but the cutting edge is almost straight, along the length, and is found on one side of the tools, while the opposite side is a cortical back.

1) General features of the side choppers

Around 15% (56/383) of the large tools in the stratigraphic layers 3 to 10 of area 2, sectors S20W10 and S21W10 are side choppers. It is to be noted that the side choppers are rarely represented, and the greatest proportion is in the layer 8, providing 28% of the large tools, the lowest in the layer 7 (3/38) **(Table 4.4.2.2.1)**.

Side choppers	**Layer 2**		**Layer 3**		**Layer 4**		**Layer 5**		**Layer 6**		**Layer 7**		**Layer 8**		**Layer 9**		**Layer 10**		**Total**
Numbers (%)	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
S20W10 (SEQ 3-4)	**4**		**10**	8	**9**	13	**0**		**0**		**0**		**9**	24	**3**		**0**		**35**
S21W10 (SEQ 3-4)	**1**		**3**		**3**		**2**		**2**		**3**		**8**	36	**3**		**1**		**26**
S21W10 (SEQ 1-2)	**-**		**-**		**-**		**1**		**3**		**1**		**-**		**-**		**-**		**5**
S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**5**		**13**	9	**12**	15	**2**		**2**		**3**		**17**	28	**6**	16	**1**		**56** (15%)
Large tools S20W10 (SEQ3-4) & S21W10 (SEQ 3-4)	**15**		**138**		**79**		**7**		**14**		**38**		**60**		**36**		**11**		**383**

Table 4.4.2.2.1 Total number of side choppers in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4), S21W10 (SEQ 3-4) and S21W10 (SEQ 1-2)

Raw materials S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Gray sandstone**		**Black sandstone**		**Quartzite**		**Mudstone**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**11**	84	**1**		**0**		**1**		**13**
Layer 4 (340-700 cm dt.)	**12**	100	**0**		**0**		**0**		**12**
Layer 5 (400-470 cm dt.)	**2**		**0**		**0**		**0**		**2**
Layer 6 (470- 520 cm dt.)	**2**		**0**		**0**		**0**		**2**
Layer 7 (520- 580 cm dt.)	**3**		**0**		**0**		**0**		**3**
Layer 8 (580-720 cm dt.)	**15**	88	**0**		**2**		**0**		**17**
Layer 9 (620-740 cm dt.)	**6**	100	**0**		**0**		**0**		**6**
Layer 10 (700-780 cm dt.)	**1**		**0**		**0**		**0**		**1**
Total	**52**	93	**1**	2	**2**	3	**1**	2	**56**

Table 4.4.2.2.2 The raw materials of side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The side choppers are made of gray sandstone in 93% (52/56) of the cases and this is quite similar to the end choppers.

The other raw materials are black sandstone, quartzite and mudstone (less than 10%), and are found from the sector S20W10 only **(Table 4.4.2.2.2)**.

2) Measurements

Measurement **S20W10 (SEQ 3-4) &** **S21W10 (SEQ 3-4)**	**Length (mm)**	**Width (mm)**	**Thickness (mm)**	**Number of side choppers**
Layer 3 (320-640 cm dt.)	131	83	46	13
Layer 4 (340-700 cm dt.)	119	80	49	12
Layer 5 (400-470 cm dt.)	151	103	49	2
Layer 6 (470- 520 cm dt.)	124	86	48	2
Layer 7 (520- 580 cm dt.)	122	77	45	3
Layer 8 (580-720 cm dt.)	126	83	45	17
Layer 9 (620-740 cm dt.)	166	137	66	6
Layer 10 (700-780 cm dt.)	124	115	73	1
Average	**131**	**89**	**50**	**56**

Table 4.4.2.2.3 Average dimensions of side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The average measurements of the side choppers are rather similar to those of the end choppers. The longest side choppers are in the lower layer 9 (166 mm), and the shortest are in the upper layer 4 (119 mm), but it is especially in the layers 9 and 5 where they are quite bigger (longer and broader) than in the other layers. The narrowest are in the layer 7 (77 mm, with only 3 specimens). The average thickness is around 50 mm, but most of the values are between 45-49 mm, with the exception of the lower layers 9 and 10, with about 66-73 mm **(Table 4.4.2.2.3, figures 4.4.2.2.4 & 4.4.2.2.5)**.

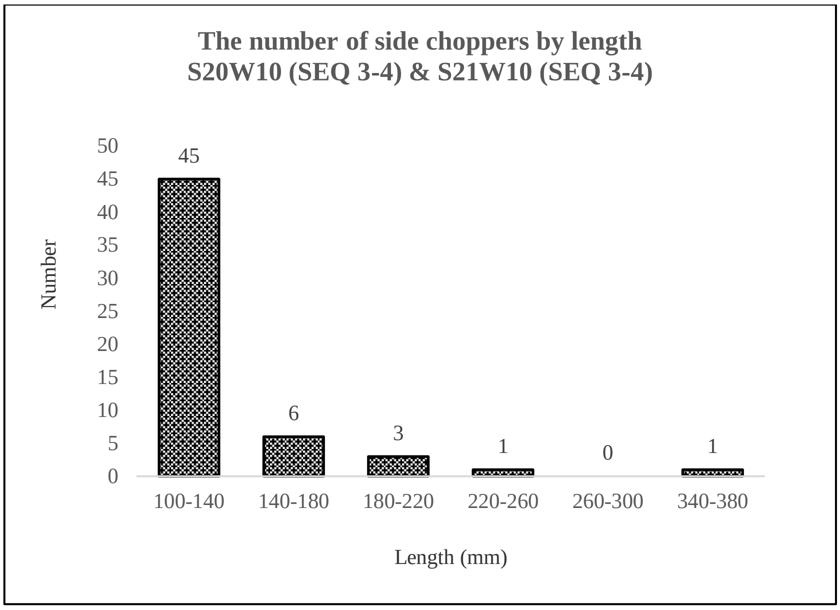


Figure 4.4.2.2.1 Distribution of the side choppers by length from Tham Lod Rockshelter area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

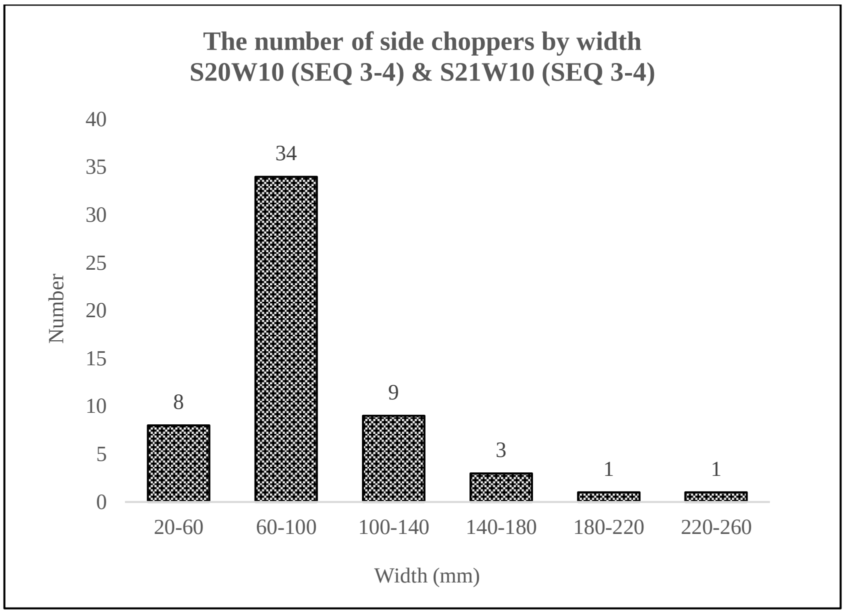


Figure 4.4.2.2.2 Distribution of the side choppers by width from Tham Lod Rockshelter area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

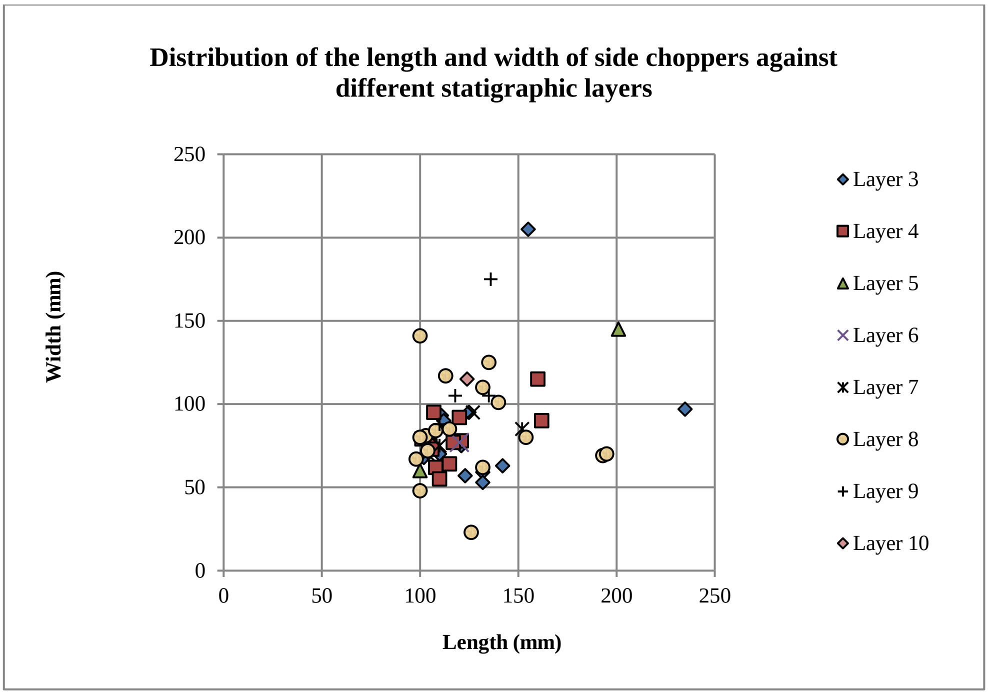


Figure 4.4.2.2.3 Scatter diagram length x width of the side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

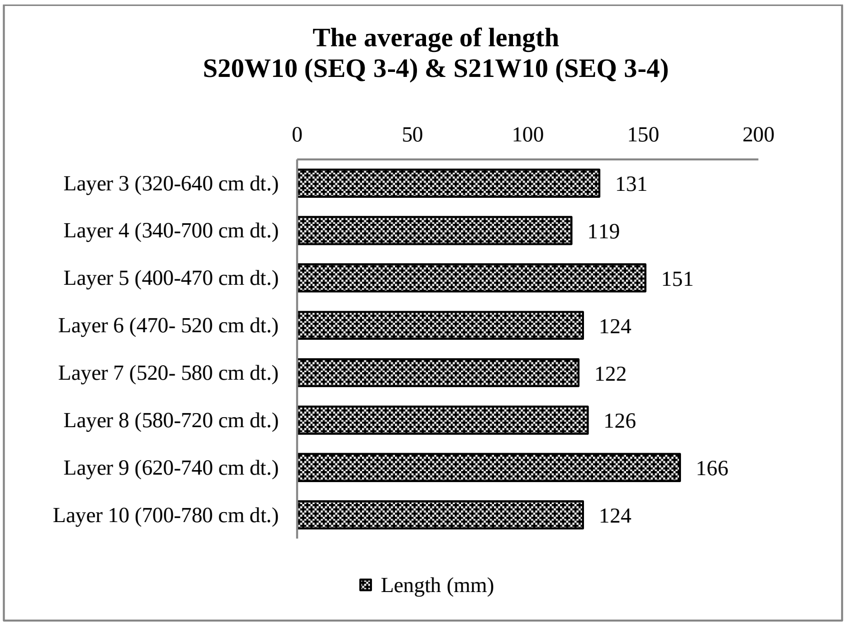


Figure 4.4.2.2.4 Distribution of the average length of the side choppers across the stratigraphy of Tham Lod Rockshelter area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

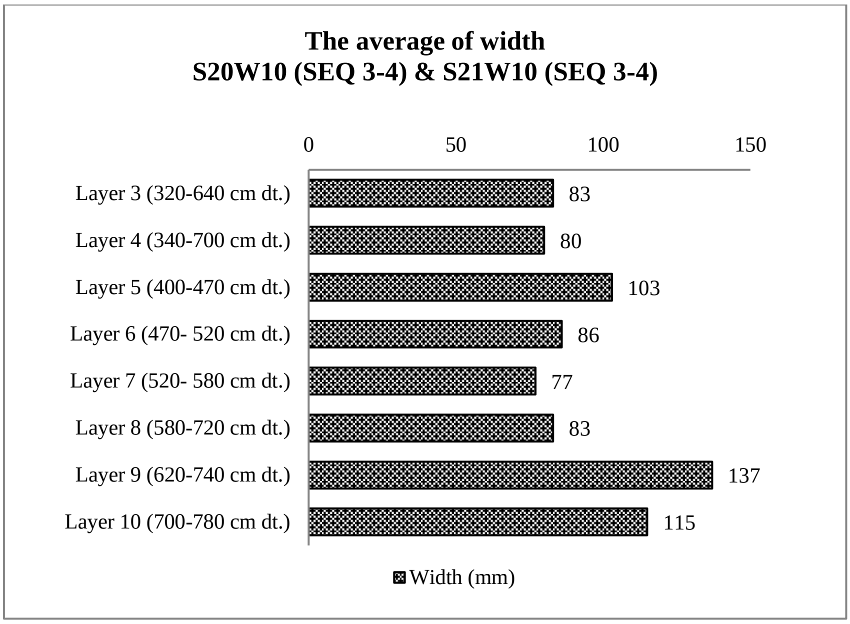


Figure 4.4.2.2.5 Distribution of the average width of the side choppers across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Weight (gr.) S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**<200**	**201-400**	**401-600**	**601-800**	**801-1000**	**1001-1200**	**1201-1400**	**1401-1600**	**1601-1800**	**>1800**	**Total**
Layer 3	1	4	3	2	0	0	1	0	1	1	**13**
Layer 4	0	2	6	2	1	1	0	0	0	0	**12**
Layer 5	0	2	0	0	0	0	0	0	0	0	**2**
Layer 6	0	1	0	0	1	0	0	0	0	0	**2**
Layer 7	0	0	1	0	2	0	0	0	0	0	**3**
Layer 8	0	4	4	1	3	3	0	2	0	0	**17**
Layer 9	0	0	0	5	0	0	0	0	1	0	**6**
Layer 10	0	0	1	0	0	0	0	0	0	0	**1**
Total	**1**	**13**	**15**	**10**	**7**	**4**	**1**	**2**	**2**	**1**	**56**

Table 4.4.2.2.4 The weight (in gram) of side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The weights of the side choppers are ranging from less than 200 g to more than 1800 g; their distribution is clearly bimodal with a main group between 201-1200 g and a smaller group of heavy tools, weighing more than 1400 g **(figure 4.4.2.2.6)**. These heavier tools occur in the richest layers, except the layer 4 where all the side choppers belong to the first group, between 200 and 1200 g **(Table 4.4.2.2.4)**.

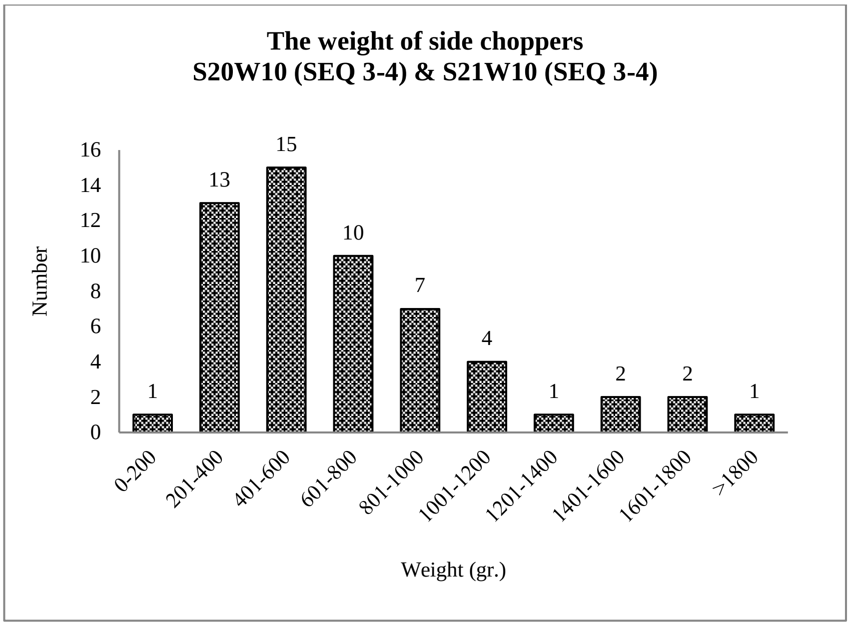


Figure 4.4.2.2.6 Distribution of the weight (in gram) of side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

3) Supports

The major supports of the side choppers are broken cobbles, 55% (31/56) or cobble fragments, 22% (12/56) while the whole cobbles, 13% (7/56), are less frequent and the split cobbles exceptional (**Table 4.4.2.2.5, figure 4.4.2.2.7**)

Supports **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Broken cobble**		**Cobble fragment**		**Whole cobble**		**Split cobble**		**Indeterminate cobble**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**8**	61	**4**		**0**		**0**		**1**		**13**
Layer 4 (340-700 cm dt.)	**6**	50	**2**		**3**		**1**		**0**		**12**
Layer 5 (400-470 cm dt.)	**1**		**0**		**0**		**1**		**0**		**2**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**0**		**1**		**0**		**2**
Layer 7 (520- 580 cm dt.)	**2**		**1**		**0**		**0**		**0**		**3**
Layer 8 (580-720 cm dt.)	**9**	53	**3**		**3**		**0**		**2**		**17**
Layer 9 (620-740 cm dt.)	**4**		**1**		**1**		**0**		**0**		**6**
Layer 10 (700-780 cm dt.)	**0**		**1**		**0**		**0**		**0**		**1**
Total	**31**	55	**12**	22	**7**	13	**3**		**3**		**56**

Table 4.4.2.2.5 The supports of side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

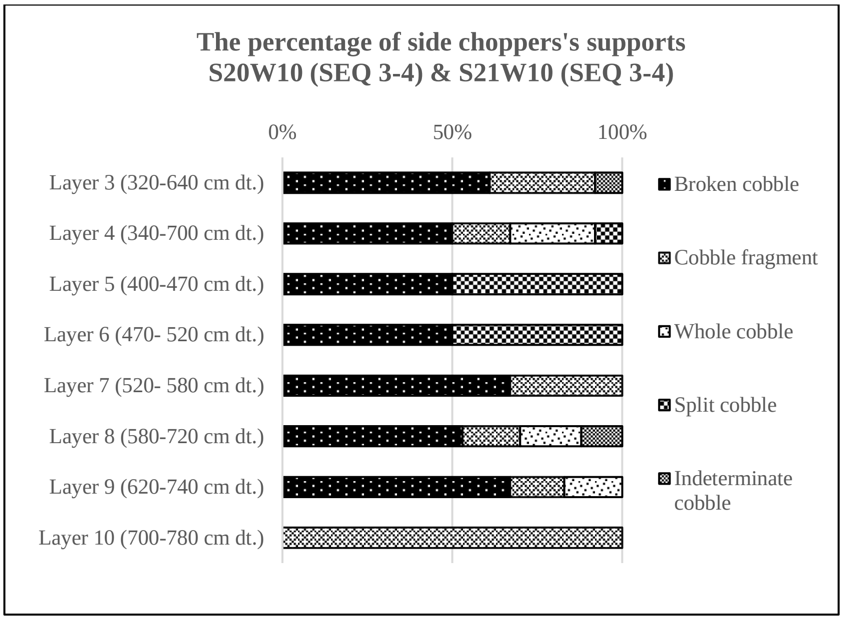


Figure 4.4.2.2.7 Distribution of the supports of side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4) General morphology of side choppers

The general morphology of side choppers is quite similar to that of the end choppers and other choppers. The irregular shape is more frequent than the other shapes for the frontal view, with about 43% (24/56), then the trapezoidal shape is representing 25% (14/56) **(Table 4.4.2.2.6)**.

In the transversal view, the trapezoidal shape is globally preponderant: 50% (28/56), but this is true for the lower layers only. In the upper layers (5 to 3), the triangular shape is more common, while it represents 34% (19/56) in the total **(Table 4.4.2.2.7)**.

4.1) Frontal view

Frontal view **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Irregular**		**Trape-zoidal**		**Oval**		**Triangular**		**Half-oval**		**D-shape**		**Pentagonal**		**Circular**		**Convex-concave**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**4**		**3**		**0**		**0**		**1**		**1**		**0**		**0**		**13**
Layer 4 (340-700 cm dt.)	**4**		**3**		**0**		**4**		**0**		**0**		**0**		**0**		**1**		**12**
Layer 5 (400-470 cm dt.)	**0**		**2**		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**2**
Layer 6 (470- 520 cm dt.)	**0**		**1**		**0**		**0**		**0**		**0**		**0**		**1**		**0**		**2**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**0**		**0**		**2**		**0**		**0**		**0**		**0**		**3**
Layer 8 (580-720 cm dt.)	**11**	65	**5**	29	**0**		**0**		**0**		**1**		**0**		**0**		**0**		**17**
Layer 9 (620-740 cm dt.)	**3**		**0**		**2**		**0**		**0**		**0**		**1**		**0**		**0**		**6**
Layer 10 (700-780 cm dt.)	**1**		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**1**
Total	**24**	43	**15**	27	**5**	9	**4**	4/56	**2**		**2**		**2**		**1**		**1**		**56**

Table 4.4.2.2.6 The frontal view of side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4.2) Transversal view

Transversal view **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Trapezoidal**		**Triangular**		**Irregular**		**Half-oval**		**D-shape**		**Almond**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**5**	38	**3**		**0**		**1**		**0**		**13**
Layer 4 (340-700 cm dt.)	**3**		**7**	59	**0**		**0**		**1**		**1**		**12**
Layer 5 (400-470 cm dt.)	**0**		**2**		**0**		**0**		**0**		**0**		**2**
Layer 6 (470- 520 cm dt.)	**1**		**1**		**0**		**0**		**0**		**0**		**2**
Layer 7 (520- 580 cm dt.)	**3**		**0**		**0**		**0**		**0**		**0**		**3**
Layer 8 (580-720 cm dt.)	**11**	65	**4**		**0**		**2**		**0**		**0**		**17**
Layer 9 (620-740 cm dt.)	**5**	83	**0**		**0**		**0**		**0**		**1**		**6**
Layer 10 (700-780 cm dt.)	**1**		**0**		**0**		**0**		**0**		**0**		**1**
Total	**28**	50	**19**	34	**3**	3/56	**2**		**2**		**2**		**56**

Table 4.4.2.2.7 The transversal view of side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

5) Shaping of the side choppers

5.1) Amount of cortex

- On the upper face

Amount of cortex **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**5**	39	**6**	46	**2**		**13**
Layer 4 (340-700 cm dt.)	**8**	67	**2**		**2**		**12**
Layer 5 (400-470 cm dt.)	**1**		**0**		**1**		**2**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**1**		**2**
Layer 7 (520- 580 cm dt.)	**1**		**1**		**1**		**3**
Layer 8 (580-720 cm dt.)	**9**	53	**3**		**5**		**17**
Layer 9 (620-740 cm dt.)	**4**		**0**		**2**		**6**
Layer 10 (700-780 cm dt.)	**0**		**0**		**1**		**1**
Total	**29**	52	**12**	21	**15**	27	**56**

Table 4.4.2.2.8 Amount of cortex on upper face of the side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

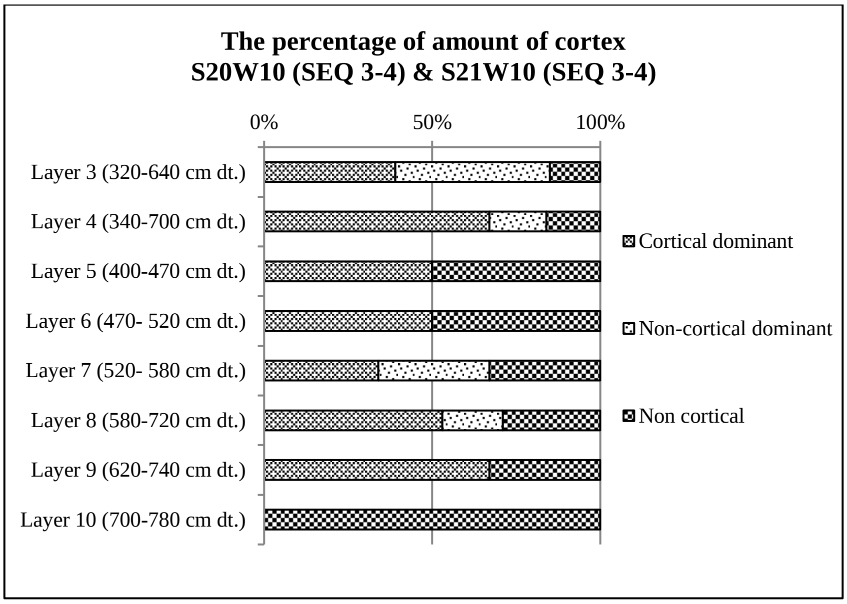


Figure 4.4.2.2.8 Distribution of the amount of cortex on the upper face of side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The upper face of the side choppers is mostly “cortical dominant”, for 52% (29/56). The highest proportions are in the layers 4 and 8 (67%). The “non-cortical dominant” and “non-cortical” upper faces represent about 25% each **(Table 4.4.2.2.8, figure 4.4.2.2.8)**.

- *On the lower face*

Amount of cortex **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Totally cortical**		**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**8**	62	**2**		**1**		**2**		**13**
Layer 4 (340-700 cm dt.)	**8**	67	**2**		**1**		**1**		**12**
Layer 5 (400-470 cm dt.)	**1**		**1**		**0**		**0**		**2**
Layer 6 (470- 520 cm dt.)	**0**		**2**		**0**		**0**		**2**
Layer 7 (520- 580 cm dt.)	**3**		**0**		**0**		**0**		**3**
Layer 8 (580-720 cm dt.)	**6**	35	**6**	35	**2**		**3**		**17**
Layer 9 (620-740 cm dt.)	**5**	83	**0**		**1**		**0**		**6**
Layer 10 (700-780 cm dt.)	**0**		**0**		**0**		**1**		**1**
Total	**31**	55	**13**	23	**5**	9	**7**	13	**56**

Table 4.4.2.2.9 Amount of cortex on lower face of the side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

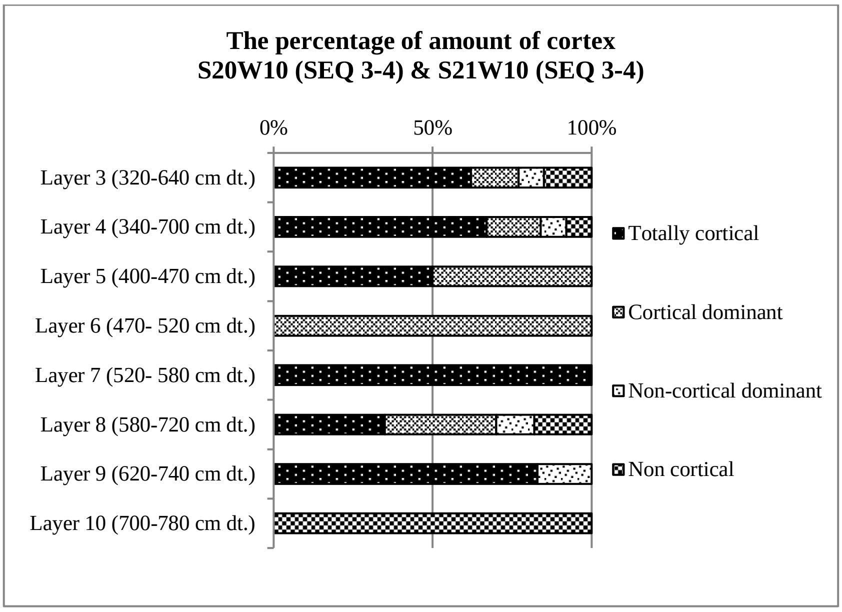


Figure 4.4.2.2.9 Amount of cortex on lower face of the side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Around 55% (31/56) of side choppers are “totally cortical” on the lower face; these are especially found in the layer 9 (5/6) but they are the majority in almost all the layers. For the other side choppers, the lower face is mostly (23%; 13/56) “cortical dominant” or, to a less extent, “non-cortical” and “non-cortical dominant” (around 20% in total) **(Table 4.4.2.2.9, figure 4.4.2.2.9)**.

5.2) Number of removals (shaping the tools)

- On the upper face

Number of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**>10 (~12)**	Total number of side choppers	Total number of removals	Average number of removals (total number of removals / total number of tools)
Layer 3	2	1	2	0	1	4	0	1	0	0	2	**13**	**71**	5.5
Layer 4	1	2	0	1	1	3	2	0	1	1	0	**12**	**65**	5.4
Layer 5	0	0	1	0	0	0	0	0	0	0	1	**2**	**15**	7.5
Layer 6	0	0	1	0	0	0	0	0	0	0	1	**2**	**15**	7.5
Layer 7	0	0	1	0	0	0	0	0	1	0	1	**3**	**24**	8.0
Layer 8	3	2	2	2	1	1	1	0	0	1	4	**17**	**91**	5.4
Layer 9	0	3	2	0	0	1	0	0	0	0	0	**6**	**18**	3.0
Layer 10	0	1	0	0	0	0	0	0	0	0	0	**1**	**2**	2.0
Total	**6**	**9**	**9**	**3**	**3**	**9**	**3**	**1**	**2**	**2**	**9**	**56**	**301**	5.4

Table 4.4.2.2.10 Number of removals on upper face of the side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

It appears that there are two groups of choppers, a first one with 1 to 3 removals, and a second one, especially in the upper layers 4 and 3, with about 6 removals. The average number of removals shaping the side choppers is around 5.5 in the layers having more than 10 items (layers 8, 4 and 3) as well as in all the layers grouped together **(Table 4.4.2.2.10)**.

- *On the lower face*

Number of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**1**	**2**	**3**	**4**	Total number of side choppers with removals on the lower face	Total number of removals	Average number of removals (total number of removals / total number of tools)
Layer 4 (340-700 cm dt.)	0	1	0	0	**1**	**2**	2
Layer 6 (470- 520 cm dt.)	2	0	0	0	**2**	**2**	1
Layer 8 (580-720 cm dt.)	2	1	1	2	**6**	**15**	2.5
Total	**4**	**2**	**1**	**2**	**9**	**19**	2.1

Table 4.4.2.2.11 Number of removals on lower face of the side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

A few side choppers also have removals on the lower face but never more than two removals, mostly one removal, and that is why they cannot be considered as chopping tools (**Table 4.4.2.2.11**).

5.3) Direction of removals

- *On the upper face*

Direction of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Unipolar**		**Bipolar-opposite**		**Bidirectional-orthogonal**		**Three-directions**		**Convergent**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**9**	69	**0**		**1**		**2**		**1**		**13**
Layer 4 (340-700 cm dt.)	**8**	67	**0**		**2**		**0**		**2**		**12**
Layer 5 (400-470 cm dt.)	**0**		**0**		**1**		**0**		**1**		**2**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**0**		**1**		**0**		**2**
Layer 7 (520- 580 cm dt.)	**1**		**1**		**0**		**1**		**0**		**3**
Layer 8 (580-720 cm dt.)	**9**	53	**2**		**2**		**2**		**2**		**17**
Layer 9 (620-740 cm dt.)	**5**	83	**0**		**1**		**0**		**0**		**6**
Layer 10 (700-780 cm dt.)	**1**		**0**		**0**		**0**		**0**		**1**
Total	**34**	61	**3**		**7**	12	**6**	11	**6**	11	**56**

Table 4.4.2.2.12 Direction of removals on upper face of the side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

- On the lower face

Direction of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Unipolar**		**Bipolar-opposite**		**Three-directions**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 4 (340-700 cm dt.)	**1**		**0**		**0**		**1**
Layer 6 (470- 520 cm dt.)	**2**		**0**		**0**		**2**
Layer 8 (580- 720 cm dt.)	**4**		**1**		**1**		**6**
Total	**7**	78	**1**	11	**1**	11	**9**

Table 4.4.2.2.13 Direction of removals on lower face of the side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The side choppers are mostly shaped by unipolar unidirectional removals, on the upper face (61%; 34/56) and of course on the lower face too, for the few “almost bifacial” specimens (80%; 7/11). The other patterns of removals like bipolar-opposite”, “bidirectional-orthogonal”, “three-directions” and “convergent” are rare and correspondent to shaping slightly extending on the edges adjacent to the main shaped edge **(Tables 4.4.2.2.12 & 4.4.2.2.13)**.

5.4) Length of the longest removal

Longest removal **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**10-20**	**21-30**	**31-40**	**41-50**	**51-60**	**61-70**	**>70**	Total number of side choppers	Average maximal length (mm)
Layer 3 (320-640 cm dt.)	3	3	4	1	2	0	0	**13**	32
Layer 4 (340-700 cm dt.)	1	4	5	0	1	0	1	**12**	39
Layer 5 (400-470 cm dt.)	0	0	0	0	1	1	0	**2**	59
Layer 6 (470- 520 cm dt.)	0	0	1	0	1	0	0	**2**	48
Layer 7 (520- 580 cm dt.)	0	1	0	1	1	0	0	**3**	37
Layer 8 (580-720 cm dt.)	1	6	2	4	2	1	1	**17**	41
Layer 9 (620-740 cm dt.)	0	3	0	1	2	0	0	**6**	38
Layer 10 (700-780 cm dt.)	1	0	0	0	0	0	0	**1**	15
Total	**6**	**17**	**12**	**7**	**10**	**2**	**2**	**56**	

Table 4.4.2.2.14 Length of the longest removal (in mm) on upper face of side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

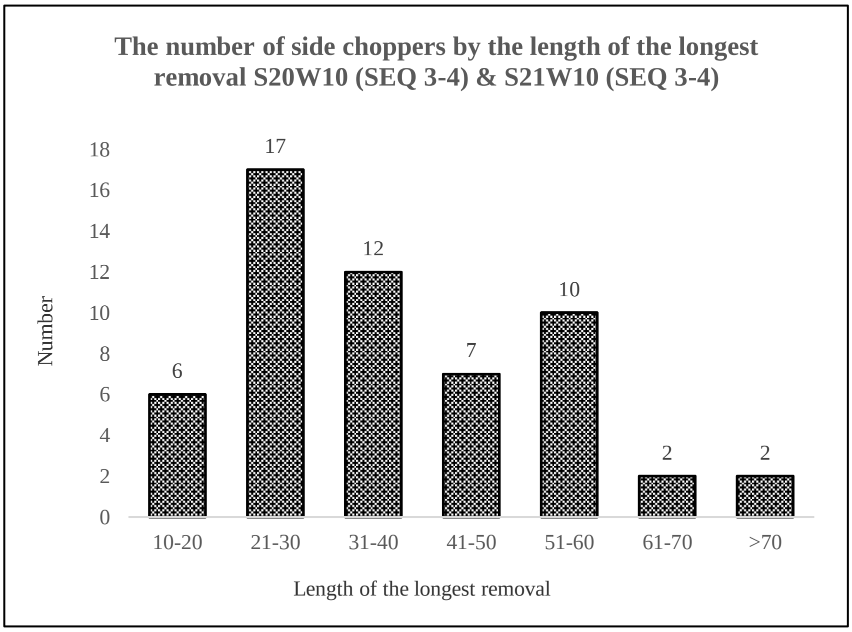


Figure 4.4.2.2.10 Distribution of length (in mm) of the longest removal on upper face of side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The length of the longest removals on the upper face varies between 10 and 93 mm, but it concentrates between 21 and 40 mm, and about 50% of the specimens are found in this range of values. The distribution appears bimodal and there may be a group of a few side choppers with longer removals, some 50-60 mm long **(Table 4.4.2.2.14, figure 4.4.2.2.10)**.

- *On the lower face*

Longest length **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**10-20**	**21-30**	**31-40**	**61-70**	Total number of side choppers	Average maximal length
Layer 4 (340-700 cm dt.)	0	1	0	0	**1**	26
Layer 6 (470- 520 cm dt.)	0	0	1	1	**2**	48
Layer 8 (580-720 cm dt.)	3	2	1	0	**6**	24
Total	**3**	**3**	**2**	**1**	**9**	

Table 4.4.2.2.15 Length of the longest removal on lower face of the side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

5.5) Extent of removals

Extent of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Marginal**		**Extensive**		**Very extensive**		**Totally invading**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**7**	54	**2**		**3**		**1**		**13**
Layer 4 (340-700 cm dt.)	**7**	59	**3**		**1**		**1**		**12**
Layer 5 (400-470 cm dt.)	**1**		**0**		**0**		**1**		**2**
Layer 6 (470- 520 cm dt.)	**0**		**2**		**0**		**0**		**2**
Layer 7 (520- 580 cm dt.)	**1**		**2**		**0**		**0**		**3**
Layer 8 (580-720 cm dt.)	**10**	59	**3**		**1**		**3**		**17**
Layer 9 (620-740 cm dt.)	**5**	83	**1**		**0**		**0**		**6**
Layer 10 (700-780 cm dt.)	**1**		**0**		**0**		**0**		**1**
Total	**32**	57	**13**	23	**5**	9	**6**	11	**56**

Table 4.4.2.2.16 Extent of removals on upper face of side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

- *On the lower face*

Extent of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Marginal**		**Extensive**		**Total**	
Stratigraphic layers	**N**	%	**N**	%	**N**	%
Layer 4 (340-700 cm dt.)	**1**		**0**		**1**	11
Layer 6 (470- 520 cm dt.)	**2**		**0**		**2**	22
Layer 8 (580-720 cm dt.)	**5**	83	**1**		**6**	67
Total	**8**	89	**1**		**9**	100

Table 4.4.2.2.17 Extent of removals on the lower face of the side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Nearly 60% of the side choppers are shaped by marginal removals (57%: 32/56) on their upper face. The “extensive” removals are providing 23% (13/56) of these tools and the very extensive or totally invading removals together about 20%. It is to be noted that “marginal” removals have an average maximal length around 30 mm **(Table 4.4.2.2.16)**. On the lower face, the removals are always marginal **(Table 4.4.2.2.17)**.

6) Morpho-functional features of side choppers: Nature of the edges

6.1) Nature of the lateral edges

Right side **S20W10 (SEQ 3-4) & S20W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**3**		**3**		**7**	54	**0**		**13**
Layer 4 (340-700 cm dt.)	**4**		**3**		**5**	42	**0**		**12**
Layer 5 (400-470 cm dt.)	**0**		**0**		**2**		**0**		**2**
Layer 6 (470- 520 cm dt.)	**0**		**0**		**1**		**1**		**2**
Layer 7 (520- 580 cm dt.)	**0**		**1**		**2**		**0**		**3**
Layer 8 (580-720 cm dt.)	**4**		**2**		**9**	53	**2**		**17**
Layer 9 (620-740 cm dt.)	**3**		**2**		**0**		**1**		**6**
Layer 10 (700-780 cm dt.)	**0**		**1**		**0**		**0**		**1**
Total	**14**	25	**12**	21	**26**	47	**4**		**56**

Left side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**2**		**1**		**10**	77	**0**		**13**
Layer 4 (340-700 cm dt.)	**4**		**1**		**6**	50	**1**		**12**
Layer 5 (400-470 cm dt.)	**1**		**0**		**1**		**0**		**2**
Layer 6 (470- 520 cm dt.)	**2**		**0**		**0**		**0**		**2**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**2**		**0**		**3**
Layer 8 (580-720 cm dt.)	**7**	41	**2**		**6**	35	**2**		**17**
Layer 9 (620-740 cm dt.)	**2**		**2**		**2**		**0**		**6**
Layer 10 (700-780 cm dt.)	**0**		**0**		**1**		**0**		**1**
Total	**19**	34	**6**	11	**28**	50	**3**		**56**

Table 4.4.2.2.18 Nature of the lateral (right and left) edges of the side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The side choppers are equally shaped by flaking on the right edge or on the left edge; sometimes they are shaped on both edges with one edge prominent and the opposite minor so that the tool cannot be called “double chopper”. The shaping is rarely bifacial (7%). When not shaped by flaking, the sides are fractured (naturally or possibly intentionally) or in cortex (**Table 4.4.2.2.18**).

6.2) Nature of the distal edge

Distal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Pointed**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**6**	46	**3**		**0**		**0**		**13**
Layer 4 (340-700 cm dt.)	**4**		**3**		**4**		**0**		**1**		**12**
Layer 5 (400-470 cm dt.)	**0**		**0**		**2**		**0**		**0**		**2**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**1**		**0**		**0**		**2**
Layer 7 (520- 580 cm dt.)	**1**		**1**		**1**		**0**		**0**		**3**
Layer 8 (580-720 cm dt.)	**6**	35	**5**	30	**5**	29	**1**		**0**		**17**
Layer 9 (620-740 cm dt.)	**1**		**1**		**4**		**0**		**0**		**6**
Layer 10 (700-780 cm dt.)	**0**		**1**		**0**		**0**		**0**		**1**
Total	**17**	30	**17**	30	**20**	36	**1**		**1**		**56**

Table 4.4.2.2.19 Nature of the distal edge of the side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The shaping of the side choppers extends on the distal edge in one third of the cases (36%: 20/56); in similar proportions the distal edge is either in cortex or fractured (about 30%: 17/56). Only two specimens are pointed tools in these sectors **(Table 4.4.2.2.19)**.

6.3) Nature of the proximal edge

Proximal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**6**	46	**4**		**3**		**0**		**13**
Layer 4 (340-700 cm dt.)	**7**	58	**3**		**2**		**0**		**12**
Layer 5 (400-470 cm dt.)	**1**		**0**		**1**		**0**		**2**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**1**		**0**		**2**
Layer 7 (520- 580 cm dt.)	**1**		**1**		**1**		**0**		**3**
Layer 8 (580-720 cm dt.)	**5**	29	**4**		**7**	41	**1**		**17**
Layer 9 (620-740 cm dt.)	**3**		**1**		**2**		**0**		**6**
Layer 10 (700-780 cm dt.)	**1**		**0**		**0**		**0**		**1**
Total	**25**	45	**13**	23	**17**	30	**1**		**56**

Table 4.4.2.2.20 Nature of the proximal edge of the side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The proximal edges of the side choppers are mostly cortical (45%: 25/56). However nearly one third of them (32%: 18/56) are shaped by unifacial removals, except one case of bifacial flaking, and this is almost as frequent as in distal position. The other proximal edges are in the form of a fracture (23%: 13/56) (**Table 4.4.2.2.20**).

7) Morpho-functional features of side choppers: Angle of the edges

7.1) Angle of right and left shaped edges

Right side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**1**		**1**		**0**		**6**
Layer 4 (340-700 cm dt.)	**1**		**3**		**2**		**0**		**6**
Layer 5 (400-470 cm dt.)	**0**		**1**		**0**		**0**		**1**
Layer 6 (470- 520 cm dt.)	**0**		**0**		**1**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**0**		**1**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**3**		**4**		**3**		**0**		**10**
Layer 9 (620-740 cm dt.)	**1**		**0**		**2**		**0**		**3**
Layer 10 (700-780 cm dt.)	**0**		**0**		**0**		**0**		**0**
Total	**9**	32	**10**	36	**9**	32	**0**		**28**

Left side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**1**		**6**		**0**		**0**		**7**
Layer 4 (340-700 cm dt.)	**1**		**4**		**0**		**1**		**6**
Layer 5 (400-470 cm dt.)	**0**		**0**		**1**		**0**		**1**
Layer 6 (470- 520 cm dt.)	**0**		**0**		**0**		**1**		**1**
Layer 7 (520- 580 cm dt.)	**0**		**1**		**1**		**0**		**2**
Layer 8 (580-720 cm dt.)	**3**		**2**		**0**		**2**		**7**
Layer 9 (620-740 cm dt.)	**1**		**1**		**1**		**0**		**3**
Layer 10 (700-780 cm dt.)	**1**		**0**		**0**		**0**		**1**
Total	**7**	25	**14**	50	**3**		**4**		**28**

Table 4.4.2.2.21 Angle of the right and left shaped edges of the side choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The side choppers are shaped on the right edge and on the left edge in approximately equal frequencies (**Table 4.4.2.2.21**) and the angles of the shaped edges are comparable on both the sides. They are mostly oblique (medium angled, 45%; 24/56) and secondarily acute (30%; 16/56). Fewer shaped edges are steep (20%) or steep inverse (4/56).

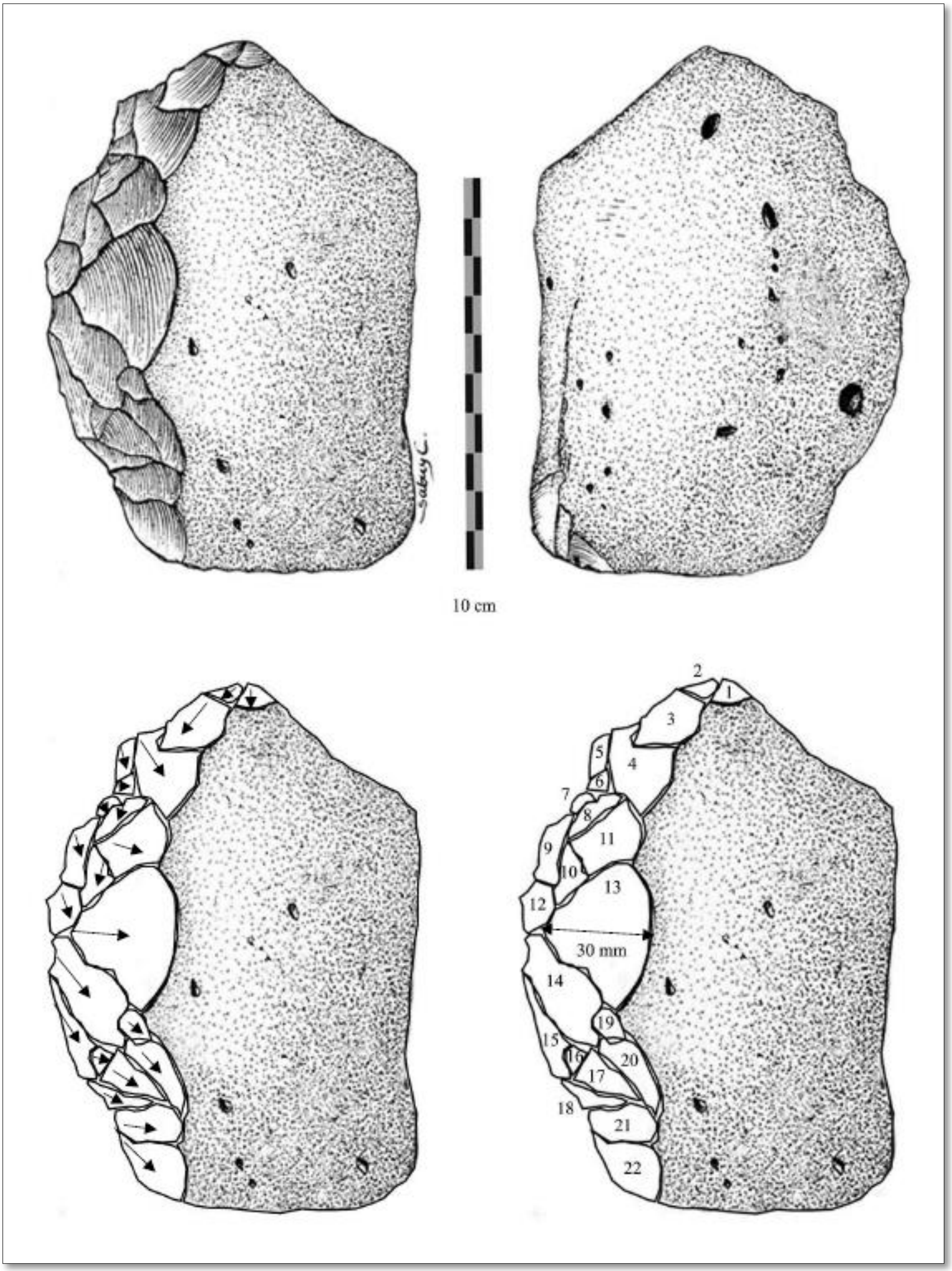


Figure 4.4.2.2.11 Main form of side chopper found at Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4), showing the direction and number of removals and retouches (drawings T. Chitkament)

4.4.2.3 Other choppers

Besides the end choppers and side choppers, various other types of choppers such as corner chopper, double chopper, nosed chopper, multiple chopper, giant chopper etc., also occur in the stratigraphic layers 3 to 10 of area 2, sectors S20W10 and S21W10. They are representing about 25% (96/383) of the large tools. In this study they will be called “other choppers”.

1) General features of the other choppers

The double choppers are by far the most common in the series (25/96: 26%), mainly in the layer 3 (40%: 13/33). Then the multiple choppers come in second position and are preponderant in the layer 7 (75%: 6/8). The other choppers are not representative in proportion, and all of them are quite variable between the layers **(Table 4.4.2.3.1)**.

Other choppers **S20W10 (SEQ 3-4) & S21W10 (SEQ -4)**	**Layer 3**		**Layer 4**		**Layer 5**		**Layer 6**		**Layer 7**		**Layer 8**		**Layer 9**		**Layer 10**		**Total**
Number (%)	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N** (%)
Corner chopper	**3**		**2**		**0**		**0**		**1**		**5**	21	**1**		**0**		**12** (13)
Double chopper	**13**	40	**3**		**0**		**1**		**1**		**5**	21	**1**		**1**		**25** (26)
Extended chopper	**0**		**1**		**0**		**0**		**0**		**1**		**4**		**1**		**7** (7)
Giant chopper	**5**	15	**0**		**0**		**0**		**0**		**0**		**0**		**1**		**6** (6)
Nosed chopper	**0**		**0**		**0**		**0**		**0**		**0**		**1**		**1**		**2**
Multiple chopper	**5**	15	**0**		**0**		**1**		**6**	75	**4**		**2**		**0**		**18** (19)
Pointed chopper	**1**		**1**		**0**		**3**		**0**		**3**		**0**		**3**		**11** (12)
Steep chopper	**4**		**0**		**0**		**0**		**0**		**2**		**0**		**0**		**6** (6)
Denticulated chopper	**2**		**2**		**0**		**0**		**0**		**4**		**1**		**0**		**9** (9)
Total	**33**		**9**		**0**		**5**		**8**		**24**		**10**		**7**		**96**
Large tools S20W10 (SEQ3-4) & S21W10 (SEQ 3-4)	**138**		**79**		**7**		**14**		**38**		**60**		**36**		**11**		**383**

Table 4.4.2.3.1 Total number of other choppers in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Other choppers **S21W10 (SEQ 1-2)**	**Layer 5**		**Layer 6**		**Layer 7**		**Total**
Number (%)	**N**	%	**N**	%	**N**	%	**N**
Corner chopper	**0**		**1**		**0**		**1**
Double chopper	**0**		**3**		**1**		**4**
Multiple chopper	**2**		**2**		**0**		**4**
Total	**2**		**6**		**1**		**9**

Table 4.4.2.3.2 Total number of other choppers in the stratigraphic layers 5 to 7 of Tham Lod Rockshelter, area 2 sectors S21W10 (SEQ 1-2)

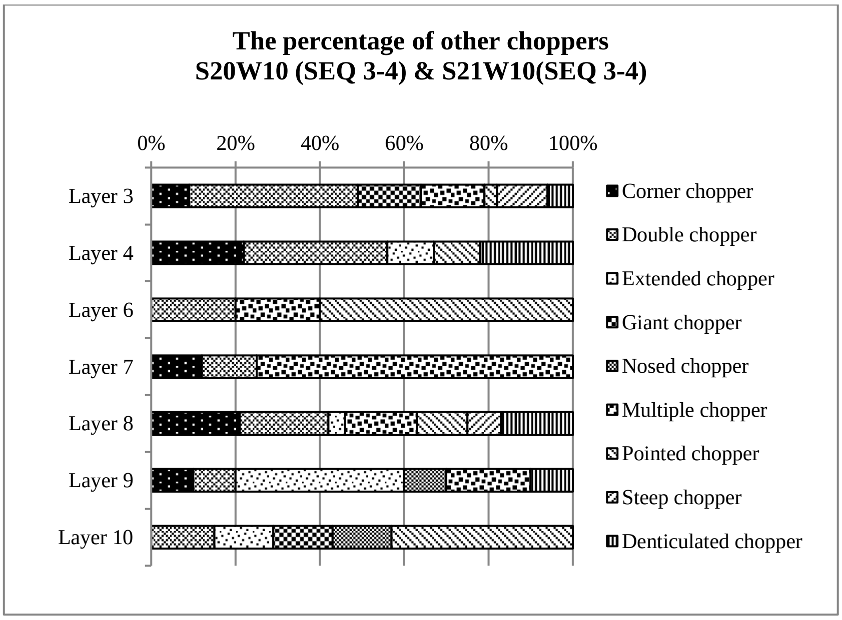


Figure 4.4.2.3.1 Distribution of the total number of other choppers in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Raw materials **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Gray sandstone**		**Black sandstone**		**Quartzite**		**Siliceous shale**		**Quartz**		**Andesite**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**30**	91	**3**		**0**		**0**		**0**		**0**		**33**
Layer 4 (340-700 cm dt.)	**8**	89	**0**		**1**		**0**		**0**		**0**		**9**
Layer 6 (470- 520 cm dt.)	**4**		**1**		**0**		**0**		**0**		**0**		**5**
Layer 7 (520- 580 cm dt.)	**8**	100	**0**		**0**		**0**		**0**		**0**		**8**
Layer 8 (580-720 cm dt.)	**20**	83	**2**		**0**		**1**		**0**		**1**		**24**
Layer 9 (620-740 cm dt.)	**8**	80	**1**		**1**		**0**		**0**		**0**		**10**
Layer 10 (700-780 cm dt.)	**6**	86	**0**		**0**		**0**		**1**		**0**		**7**
Total	**84**	88	**7**	7	**2**		**1**		**1**		**1**		**96**

Table 4.4.2.3.3 The raw materials of other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The large majority of the other choppers are in gray sandstone (nearly 90% in the whole sequence); this is similar to the composition of the end and side choppers, and of the lithic assemblage in general. Far behind, the black sandstone was used to make these tools, then other materials like quartzite, siliceous shale, quartz and andesite are extremely rare **(Table 4.4.2.3.3)**.

2) Measurements

Measurement **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Length (mm)**	**Width (mm)**	**Thickness (mm)**	**Number of other choppers**
Layer 3 (320-640 cm dt.)	142	94	58	33
Layer 4 (340-700 cm dt.)	110	83	49	9
Layer 6 (470- 520 cm dt.)	125	62	31	5
Layer 7 (520- 580 cm dt.)	125	85	58	8
Layer 8 (580-720 cm dt.)	125	83	56	24
Layer 9 (620-740 cm dt.)	114	89	50	10
Layer 10 (700-780 cm dt.)	151	98	66	7
Average	**130**	**86**	**56**	**96**

Table 4.4.2.3.4 Average dimensions of other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & 21W10 (SEQ 3-4)

The average dimensions of the other choppers are a little smaller than those of the side and end choppers. They vary within a large range of 40 mm for the length (between 110 and 151 mm) and slightly less for the width and thickness. The other choppers are quite bigger in the layer 10, as well as in the layer 3 except for the thickness; this is due to the presence of giant choppers (1 in the layer 10 and 5 in the layer 3). The narrowest and thinner specimens are in the layer 6 (62 mm and 31 mm) but this is the poorest layer (5 other choppers only) **(Table 4.4.2.3.4, figures 4.4.2.3.5 & 4.4.2.3.6)**.

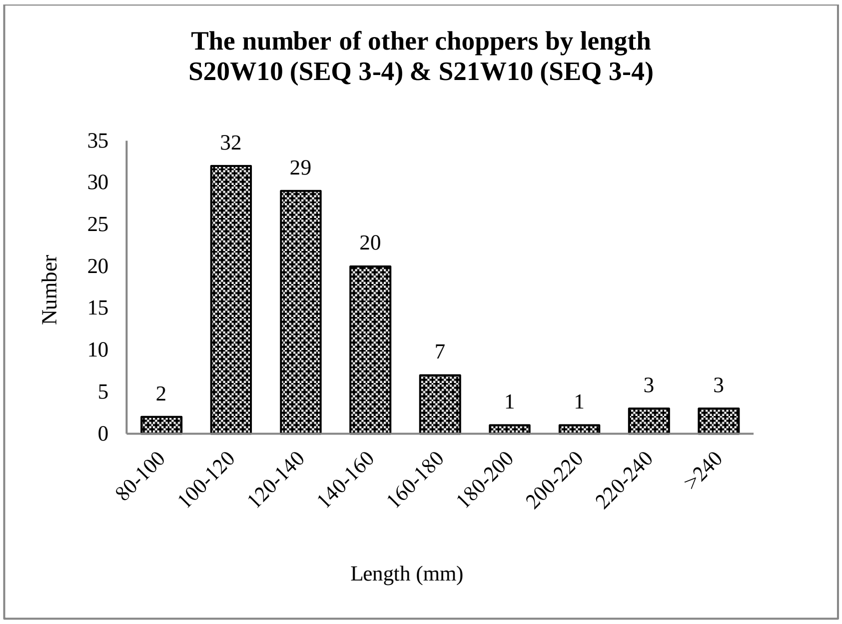


Figure 4.4.2.3.2 Distribution of the other choppers by length from Tham Lod Rockshelter area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

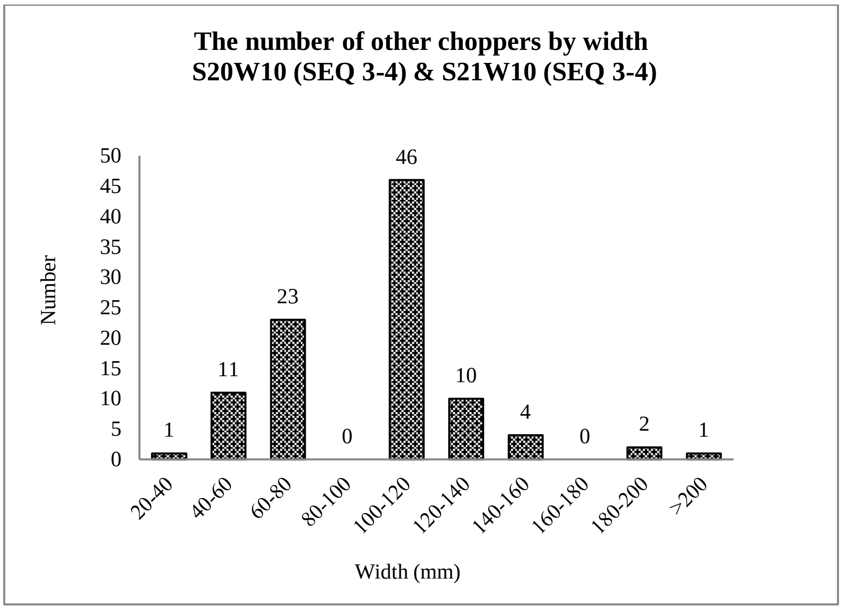


Figure 4.4.2.3.3 Distribution of the other choppers by width from Tham Lod Rockshelter area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

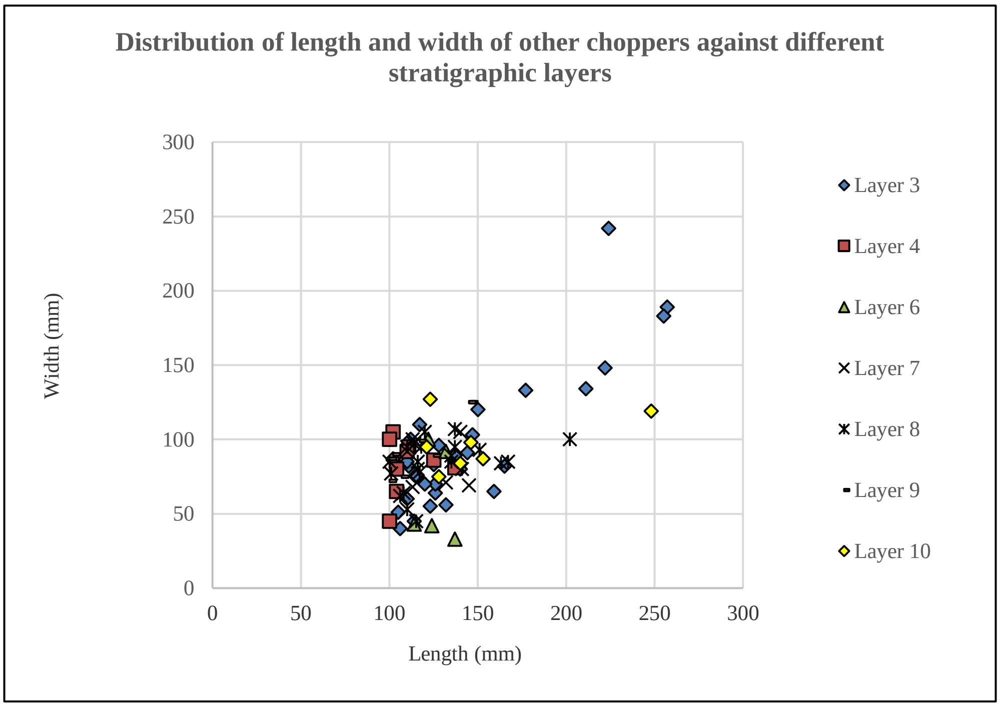


Figure 4.4.2.3.4 Scatter diagram length x width of the end choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The other choppers are very close to each other on the basis of their length and width, except a few of them, the giant choppers, which are clearly bigger **(figure 4.4.2.3.4)**.

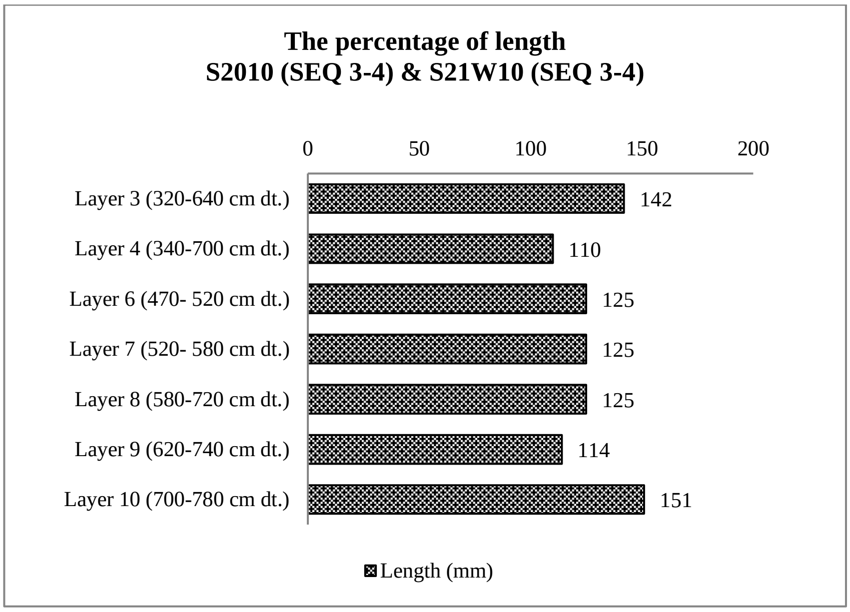


Figure 4.4.2.3.5 Distribution of the average length of other choppers across the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

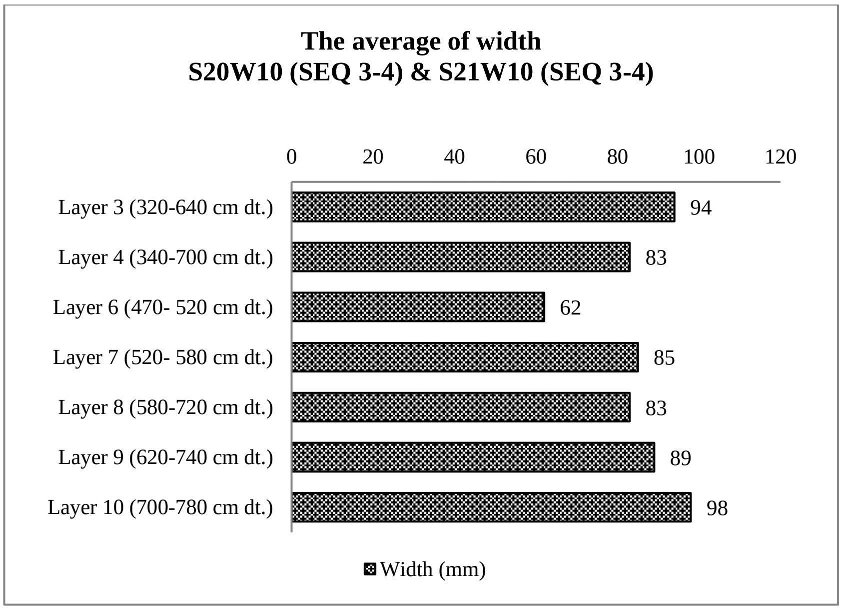


Figure 4.4.2.3.6 Distribution of the average width of other choppers across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Weight (gr.) **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**<200**	**201-400**	**401-600**	**601-800**	**801-1000**	**1001-1200**	**1201-1400**	**1401-1600**	**1601-1800**	**>1800**	**Total**
Layer 3	3	4	6	5	5	1	1	1	1	6	**33**
Layer 4	0	3	1	3	1	0	0	1	0	0	**9**
Layer 6	0	1	1	0	1	1	0	1	0	0	**5**
Layer 7	0	1	2	2	1	1	0	0	0	1	**8**
Layer 8	0	6	4	3	3	3	3	2	0	0	**24**
Layer 9	0	2	3	2	1	0	0	1	0	1	**10**
Layer 10	0	1	0	2	2	0	0	1	0	1	**7**
Total	**3**	**18**	**17**	**17**	**14**	**6**	**4**	**7**	**1**	**9**	**96**

Table 4.4.2.3.5 The weight (in gram) of other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

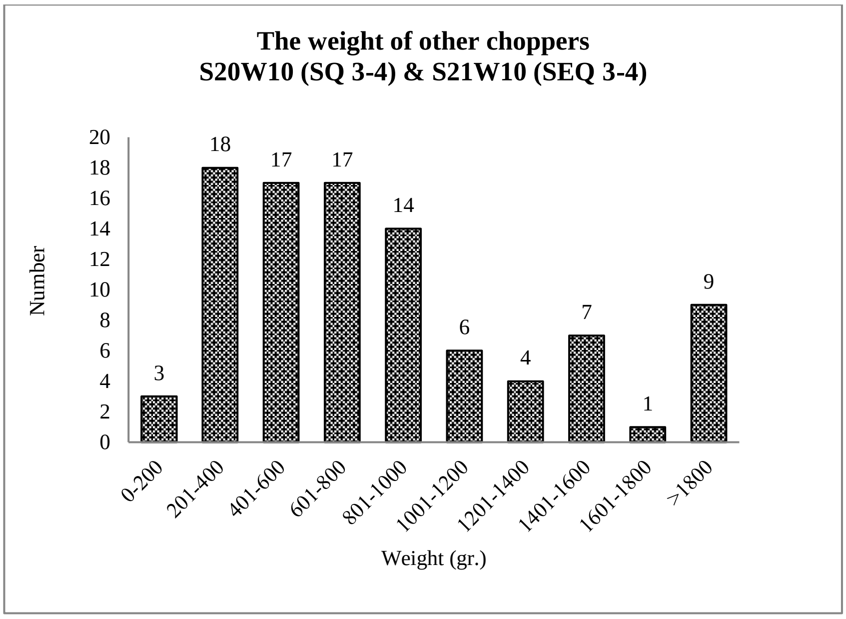


Figure 4.4.2.3.7 Distribution of the weight (in gram) of other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The weight distribution of the other choppers is comparable with the side and end choppers. Most of the tools are between 201 and 1000 g (66 tools; nearly 70%). There is also, as for the end choppers, a group of heavier tools and these are especially found in the upper layer 3 (up to 7500 g) **(Table 4.4.2.3.5, figure 4.4.2.3.7)**.

3) Supports

Supports S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Broken cobble**		**Cobble fragment**		**Whole cobble**		**Split cobble**		**Flake**		**Fragment**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**16**	49	**10**	30	**6**	18	**0**		**0**		**1**		**33**
Layer 4 (340-700 cm dt.)	**6**	67	**1**		**2**		**0**		**0**		**0**		**9**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**0**		**1**		**3**		**0**		**5**
Layer 7 (520- 580 cm dt.)	**7**	87	**0**		**1**		**0**		**0**		**0**		**8**
Layer 8 (580-720 cm dt.)	**19**	79	**2**		**2**		**1**		**0**		**0**		**24**
Layer 9 (620-740 cm dt.)	**6**	60	**1**		**2**		**1**		**0**		**0**		**10**
Layer 10 (700-780 cm dt.)	**4**		**1**		**1**		**1**		**0**		**0**		**7**
Total	**59**	59	**15**	16	**14**	15	**4**		**3**		**1**		**96**

Table 4.4.2.3.6 The supports of other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

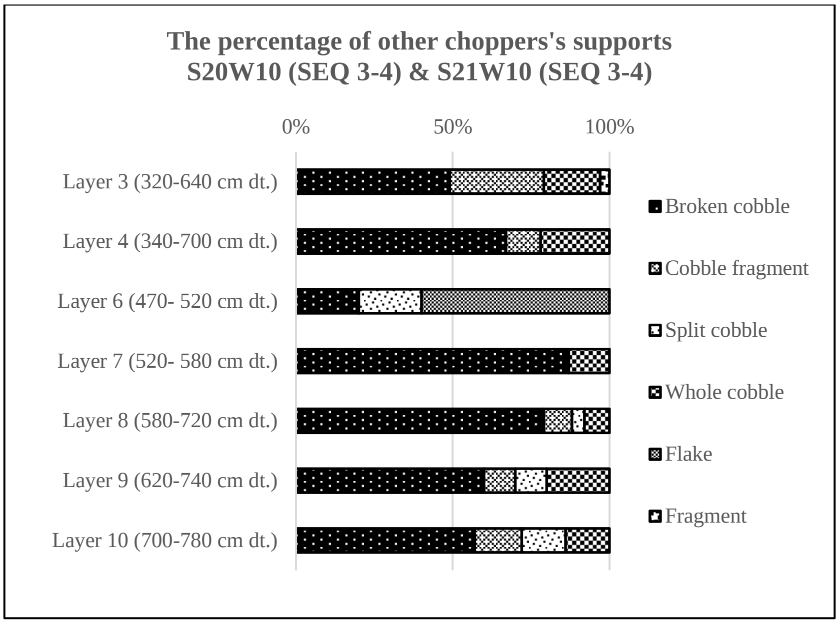


Figure 4.4.2.3.8 Distribution of the support of other choppers from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

A large majority of other choppers are made on broken cobbles (nearly 60%) and secondarily on cobble fragments or whole cobles. The greatest importance of broken cobbles is in the layers 7 to 8 (87-79%) and the lowest is in the layer 6, where the flakes are remarkable (60%), but very few in numbers **(Table 4.4.2.3.6, figure 4.4.2.3.8)**.

4) General morphology of other choppers

The other choppers often exhibit irregular shapes in frontal view (27%: 26/96), globally with the same frequency as the end choppers but less than the side choppers. The highest importance is in the layer 8 (46%), where also many side choppers are irregular (65%). Then the trapezoidal and oval shapes come next (24% and 21% respectively) **(Table 4.4.2.3.7)**.

For the transversal view, the triangular shape is more common (29%: 28/96), along with the trapezoidal shape (25%: 24/96). The high frequency of triangular cross-sections in the layer 7 (88%: 7/8) may be related to the similar high frequency of multiple choppers, shaped by removals in, at least, two directions (see below) probably joining in the middle of the tool **(Table 4.4.2.3.8)**.

4.1) Frontal view

Frontal view **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Irregular**		**Trape-zoidal**		**Oval**		**Trian-gular**		**Half-oval**		**D-shape**		**Penta-gonal**		**Circular**		**Convex-concave**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**7**	21	**10**	31	**5**	15	**4**		**3**		**2**		**1**		**1**		**0**		**33**
Layer 4 (340-700 cm dt.)	**4**		**0**		**2**		**1**		**2**		**0**		**0**		**0**		**0**		**9**
Layer 6 (470- 520 cm dt.)	**1**		**2**		**1**		**0**		**0**		**0**		**1**		**0**		**0**		**5**
Layer 7 (520- 580 cm dt.)	**0**		**1**		**3**		**0**		**1**		**2**		**0**		**0**		**1**		**8**
Layer 8 (580-720 cm dt.)	**11**	46	**8**	33	**4**		**1**		**0**		**0**		**0**		**0**		**0**		**24**
Layer 9 (620-740 cm dt.)	**2**		**1**		**2**		**2**		**2**		**0**		**1**		**0**		**0**		**10**
Layer 10 (700-780 cm dt.)	**1**		**1**		**3**		**2**		**0**		**0**		**0**		**0**		**0**		**7**
Total	**26**	27	**23**	24	**20**	21	**10**	11	**8**	8	**4**	4/96	**3**	3/96	**1**		**1**		**96**

Table 4.4.2.3.7 The frontal view of other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4.2) Transversal view

Transversal view **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Triangular**		**Trape-zoidal**		**Oval**		**Irregular**		**Half-oval**		**Pentagonal**		**D-shape**		**Convex-concave**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**12**	37	**7**	21	**6**	18	**3**		**1**		**0**		**0**		**33**
Layer 4 (340-700 cm dt.)	**1**		**1**		**1**		**3**		**2**		**0**		**1**		**0**		**9**
Layer 6 (470- 520 cm dt.)	**0**		**0**		**2**		**0**		**1**		**2**		**0**		**0**		**5**
Layer 7 (520- 580 cm dt.)	**7**	88	**0**		**0**		**0**		**0**		**1**		**0**		**0**		**8**
Layer 8 (580-720 cm dt.)	**9**	38	**6**	25	**4**		**1**		**1**		**2**		**1**		**0**		**24**
Layer 9 (620-740 cm dt.)	**4**		**4**		**1**		**0**		**0**		**0**		**1**		**0**		**10**
Layer 10 (700-780 cm dt.)	**3**		**1**		**2**		**0**		**0**		**0**		**0**		**1**		**7**
Total	**28**	29	**24**	25	**17**	18	**10**	11	**7**	7	**6**	6	**3**	3/96	**1**		**96**

Table 4.4.2.3.8 The transversal view of other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

5) Shaping of the other choppers

5.1) Amount of cortex

- On the upper face

Amount of cortex **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**22**	67	**7**	21	**4**		**33**
Layer 4 (340-700 cm dt.)	**5**	56	**2**		**2**		**9**
Layer 6 (470- 520 cm dt.)	**2**		**0**		**3**		**5**
Layer 7 (520- 580 cm dt.)	**5**	62	**1**		**2**		**8**
Layer 8 (580-720 cm dt.)	**14**	58	**6**	25	**4**		**24**
Layer 9 (620-740 cm dt.)	**6**	60	**4**		**0**		**10**
Layer 10 (700-780 cm dt.)	**3**		**4**		**0**		**7**
Total	**57**	59	**24**	24	**15**	16	**96**

Table 4.4.2.3.9 Amount of cortex on upper face of the other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

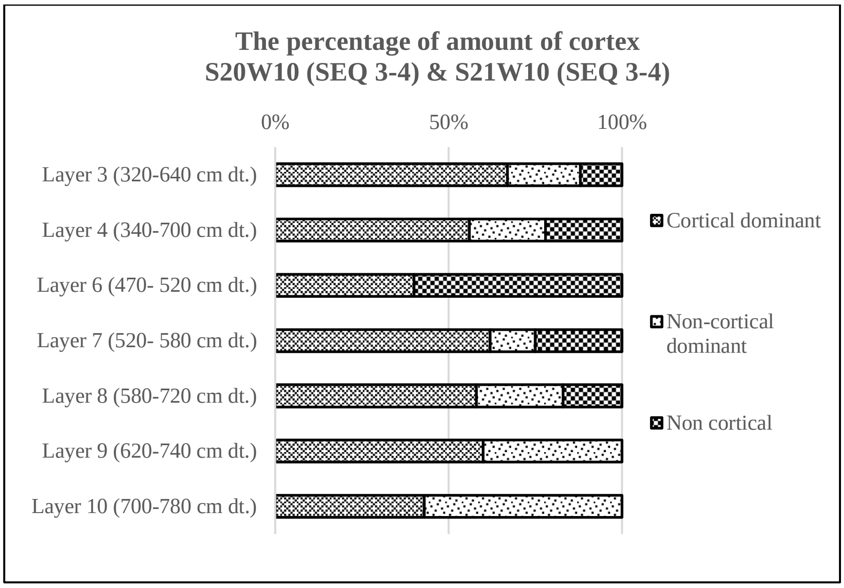


Figure 4.4.2.3.9 Distribution of the amount of cortex on the upper face of other choppers from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Like the end and side choppers, the other choppers are, mostly “cortical dominant” on the upper face, for nearly 60% (57/96). These percentages vary between 40% and 60% in all the layers (40% for the poorest layers), except in the upper layer 3 where it reaches 67% (22/33). Only 40% of other choppers have little cortex, and out of them, the “non-cortical dominant” are representing 25% (24/96), and then “non-cortical” about 16% **(Table 4.4.2.3.9, figure 4.4.2.3.9)**.

- *On the lower face*

Amount of cortex **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Totally cortical**		**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**17**	52	**8**	24	**3**		**5**	15	**33**
Layer 4 (340-700 cm dt.)	**7**	78	**2**		**0**		**0**		**9**
Layer 6 (470- 520 cm dt.)	**2**		**2**		**1**		**0**		**5**
Layer 7 (520- 580 cm dt.)	**5**	62	**2**		**0**		**1**		**8**
Layer 8 (580-720 cm dt.)	**14**	58	**6**	25	**1**		**3**		**24**
Layer 9 (620-740 cm dt.)	**4**		**5**	50	**0**		**1**		**10**
Layer 10 (700-780 cm dt.)	**3**		**3**		**0**		**1**		**7**
Total	**52**	54	**28**	29	**5**	5	**11**	12	**96**

Table 4.4.2.3.10 Amount of cortex on lower face of the other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

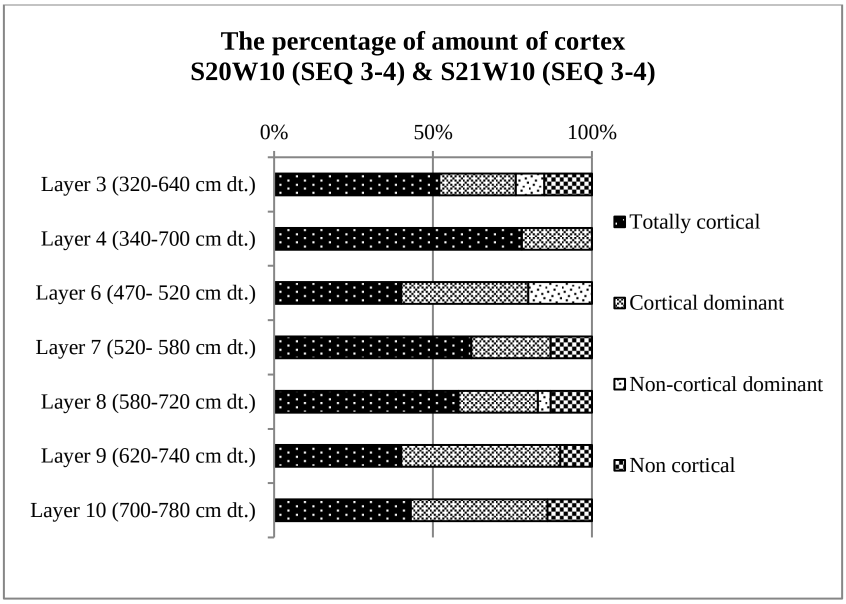


Figure 4.4.2.3.10 Amount of cortex on lower face of the other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Approximately 55% (52/96) of other choppers are “totally cortical” on the lower face. The greatest proportion is in the layer 4 (78%: 7/9) and the lowest is in the layers 6 and 9 (40%). Thereafter, the lower faces are “cortical dominant” (29%; 28/96), remarkably 50% (5/10) in the layer 9. The “non-cortical” and “non-cortical dominant” are around 17% in the total. It is to be noted that the other choppers are very similar to the end choppers regarding the extent of cortex on the lower face as well as on the upper face **(Table 4.4.2.3.10, figure 4.4.2.3.10)**

5.2) Number of removals (shaping the tools)

- On the upper face

Number of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**>10 (~12)**	Total number of other choppers	Total number of removals	Average number of removals (total number of removals / total number of tools)
Layer 3	3	4	3	5	4	5	3	1	2	1	2	**33**	**171**	5,2
Layer 4	1	2	0	2	1	1	0	1	0	0	1	**9**	**44**	4,9
Layer 6	0	0	1	0	0	1	1	0	0	0	2	**5**	**40**	8,0
Layer 7	1	0	0	0	0	2	1	0	1	1	2	**8**	**63**	7,9
Layer 8	1	1	4	2	2	1	6	0	1	1	5	**24**	**160**	6,7
Layer 9	1	2	0	2	1	2	1	0	0	0	1	**10**	**49**	4.9
Layer 10	2	2	3	0	0	0	0	0	0	0	0	**7**	**15**	2,1
Total	**9**	**11**	**11**	**11**	**8**	**12**	**12**	**2**	**4**	**3**	**13**	**96**	**542**	5,6

Table 4.4.2.3.11 Number of removals on upper face of the other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The average number of removals shaping the other choppers is around 5.6 for the whole stratigraphic sequence; in the different layers it varies between 5 and 8, except in the lower layer 10 where it much lower: 2.1 Actually the other choppers include several types of tools and therefore the number of removals varies within a large range of values, from 1 to more than 10, with higher values for the multiple choppers **(Table 4.4.2.3.11)**.

- *On the lower face*

Number of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4**	**1**	**2**	**3**	**4**	**6**	Total number of other choppers with removals on the lower face	Total number of removals	Average number of removals (total number of removals / total number of tools)
Layer 3 (320-640 cm dt.)	2	1	1	3	0	**7**	**19**	2,7
Layer 4 (340-700 cm dt.)	0	0	0	0	1	**1**	**6**	6,0
Layer 6 (470- 520 cm dt.)	0	1	0	0	0	**1**	**2**	2,0
Layer 7 (520- 580 cm dt.)	0	1	0	0	0	**1**	**2**	2,0
Layer 8 (580-720 cm dt.)	1	2	3	0	0	**6**	**14**	2,3
Layer 9 (620-740 cm dt.)	1	1	0	0	0	**2**	**3**	1,5
Layer 10 (700-780 cm dt.)	1	0	0	0	0	**1**	**1**	1,0
Total	5	6	4	3	1	**19**	**47**	2,5

Table 4.4.2.3.12 Number of removals on lower face of the other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The main number of removals is representing around 2 or 1 removals, but the other removals also have discovered, and very few on the lower face, therefore the proportion is statistically not significant for the number of removals **(Table 4.4.2.3.12)**.

5.3) Length of the longest removal

- On the upper face

Longest removal S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**10-20**	**21-30**	**31-40**	**41-50**	**51-60**	**61-70**	**71-80**	**81-90**	Total number of other choppers	Average maximal length (mm)
Layer 3 (320-640 cm dt.)	0	9	8	6	1	8	0	1	**33**	45
Layer 4 (340-700 cm dt.)	1	2	5	1	0	0	0	0	**9**	34
Layer 6 (470- 520 cm dt.)	0	1	1	1	1	1	0	0	**5**	46
Layer 7 (520- 580 cm dt.)	1	0	1	3	2	0	0	1	**8**	48
Layer 8 (580-720 cm dt.)	4	2	4	4	4	2	1	3	**24**	43
Layer 9 (620-740 cm dt.)	1	2	1	4	2	0	0	0	**10**	41
Layer 10 (700-780 cm dt.)	0	1	0	1	0	2	2	1	**7**	62
Total	7	17	20	20	10	13	3	6	**96**	

Table 4.4.2.3.13 Length of the longest removal (in mm) on upper face of other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

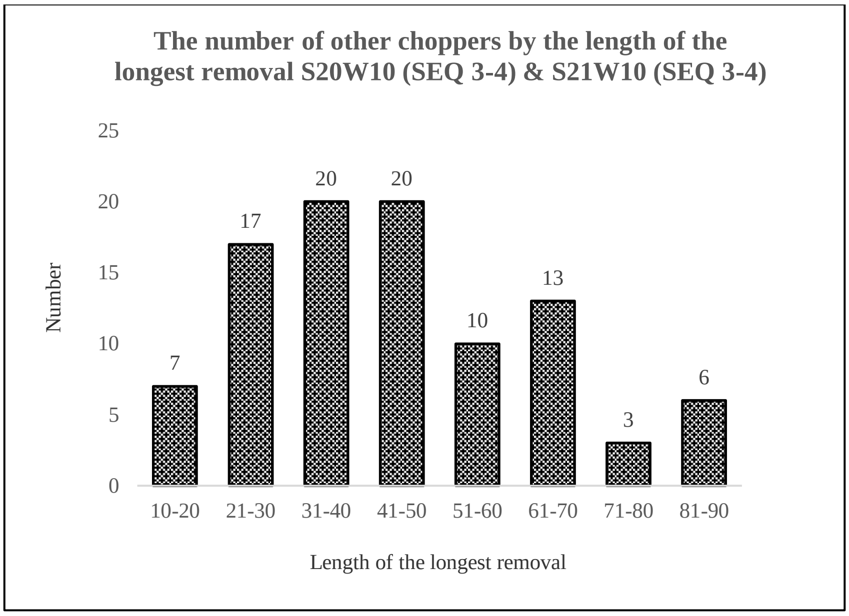


Figure 4.4.2.3.11 Distribution of length of the longest removal (in mm) on upper face of other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The length of longest removal of other choppers ranges from 6 to 97 mm, but the most significant values are between 31 and 50 mm (40 tools: 42%). The distribution is bimodal and even trimodal, the third mode being linked with the giant choppers. The second mode is around 60-70 mm, that is slightly longer than for the side choppers (while for the end choppers this measurement shows a normal/unimodal distribution; **Table 4.4.2.3.13, figure 4.4.2.3.11**).

- *On the lower face*

Longest length **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4**	**10-20**	**21-30**	**31-40**	**41-50**	**51-60**	**61-70**	**71-80**	Total number of other choppers	Average maximal length
Layer 3 (320-640 cm dt.)	3	1	1	1	0	1	0	**7**	**32**
Layer 4 (340-700 cm dt.)	0	0	1	0	0	0	0	**1**	**32**
Layer 6 (470- 520 cm dt.)	0	0	0	1	0	0	0	**1**	**46**
Layer 7 (520- 580 cm dt.)	0	0	1	0	0	0	0	**1**	**36**
Layer 8 (580-720 cm dt.)	2	1	1	0	1	1	0	**6**	**34**
Layer 9 (620-740 cm dt.)	0	0	0	0	0	1	1	**2**	**77**
Layer 10 (700-780 cm dt.)	0	1	0	0	0	0	0	**1**	**30**
Total	**5**	**3**	**4**	**2**	**1**	**3**	**1**	**19**	

Table 4.4.2.3.14 Length of the longest removal on lower face of other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The length of longest removal on the lower face is mostly less than 40 mm, (63%; 12/19), but there is also some longer removal, especially in the layer 9 (80 mm; **Table 4.4.2.3.14**).

5.4) Extent of removals

- *On the upper face*

Extent of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Marginal**		**Extensive**		**Very-extensive**		**Totally invading**		**Undeter-mined**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**18**	55	**10**	33	**4**		**1**		**0**		**33**
Layer 4 (340-700 cm dt.)	**4**		**5**	56	**0**		**0**		**0**		**9**
Layer 6 (470- 520 cm dt.)	**0**		**3**		**0**		**2**		**0**		**5**
Layer 7 (520- 580 cm dt.)	**3**		**4**		**0**		**1**		**0**		**8**
Layer 8 (580-720 cm dt.)	**15**	62	**3**		**3**		**1**		**2**		**24**
Layer 9 (620-740 cm dt.)	**5**	50	**1**		**4**		**0**		**0**		**10**
Layer 10 (700-780 cm dt.)	**3**		**4**		**0**		**0**		**0**		**7**
Total	**48**	50	**30**	31	**11**	12	**5**	5	**2**		**96**

Table 4.4.2.3.15 Extent of removals on upper face of other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

- *On the lower face*

Extent of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Marginal**		**Extensive**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**6**	86	**1**		**7**
Layer 4 (340-700 cm dt.)	**1**		**0**		**1**
Layer 6 (470- 520 cm dt.)	**0**		**1**		**1**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**1**
Layer 8 (580-720 cm dt.)	**4**		**2**		**6**
Layer 9 (620-740 cm dt.)	**2**		**0**		**2**
Layer 10 (700-780 cm dt.)	**1**		**0**		**1**
Total	**15**	79	**4**		**19**

Table 4.4.2.3.16 Extent of removals on upper face of other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The “marginal” removals are mostly found, on the upper face (50%: 48/96), as well as on the lower face (nearly 80%: 15/19) but in the layers 4, 6, 7 and 10, they are slightly more extensive than in the other layers **(Tables 4.4.2.3.15 and 4.4.2.3.16)**.

6) Morpho-functional features of other choppers: Nature of the edges

6.1) Nature of the lateral edges

Right side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**10**	30	**14**	43	**8**	24	**1**		**33**
Layer 4 (340-700 cm dt.)	**1**		**0**		**8**	89	**0**		**9**
Layer 6 (470- 520 cm dt.)	**2**		**0**		**3**		**0**		**5**
Layer 7 (520- 580 cm dt.)	**3**		**1**		**4**		**0**		**8**
Layer 8 (580-720 cm dt.)	**5**	21	**4**		**13**	54	**2**		**24**
Layer 9 (620-740 cm dt.)	**5**	50	**1**		**4**		**0**		**10**
Layer 10 (700-780 cm dt.)	**3**		**3**		**1**		**0**		**7**
Total	**29**	30	**23**	24	**41**	42	**3**	3	**96**

Left side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**11**	34	**9**	27	**11**	33	**2**		**33**
Layer 4 (340-700 cm dt.)	**3**		**3**		**2**		**1**		**9**
Layer 6 (470- 520 cm dt.)	**2**		**0**		**3**		**0**		**5**
Layer 7 (520- 580 cm dt.)	**6**	75	**1**		**1**		**0**		**8**
Layer 8 (580-720 cm dt.)	**17**	71	**3**		**2**		**2**		**24**
Layer 9 (620-740 cm dt.)	**2**		**2**		**5**	50	**1**		**10**
Layer 10 (700-780 cm dt.)	**2**		**2**		**3**		**0**		**7**
Total	**43**	44	**20**	21	**27**	28	**6**	7	**96**

Table 4.4.2.3.17 Nature of the lateral (right and left) edges of the other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The other choppers seem to be more often shaped on the right edge (46%: 44/96) than on the left edge (36%: 35/96) and conversely more often cortical on the left edge (44%: 43/96) than on the right edge (30%: 29/96). Shaping is mostly unifacial on both sides. The other sides (20 to 25%) are fractures, equally represented on both sides **(Table 4.4.2.3.17)**.

6.2) Nature of the distal edge

Distal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Pointed**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**5**	15	**20**	61	**3**		**1**		**33**
Layer 4 (340-700 cm dt.)	**2**		**0**		**6**	67	**1**		**0**		**9**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**4**		**0**		**0**		**5**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**7**	88	**0**		**0**		**8**
Layer 8 (580-720 cm dt.)	**3**		**2**		**13**	54	**4**		**2**		**24**
Layer 9 (620-740 cm dt.)	**0**		**2**		**7**	70	**1**		**0**		**10**
Layer 10 (700-780 cm dt.)	**0**		**0**		**3**		**0**		**4**		**7**
Total	**11**	12	**9**	9	**60**	61	**9**	10	**7**	7	**96**

Table 4.4.2.3.18 Nature of the distal edge of the other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The shaping of the other choppers mostly occurs on the distal edge (72%: 69/96) and it is unifacial in most of the cases (more than 60%: 60/96). Cortex and fracture in distal position are much fewer than in lateral position (about 20%). The pointed tools are even less (7%) and they result either from a bilateral shaping or from a unilateral shaping or also from a fracture (**Table 4.4.2.3.18)**.

6.3) Nature of the proximal edge

Proximal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Pointed**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**13**	40	**8**	24	**10**	30	**2**		**0**		**33**
Layer 4 (340-700 cm dt.)	**4**		**3**		**1**		**1**		**0**		**9**
Layer 6 (470- 520 cm dt.)	**3**		**0**		**2**		**0**		**0**		**5**
Layer 7 (520- 580 cm dt.)	**2**		**1**		**5**	63	**0**		**0**		**8**
Layer 8 (580-720 cm dt.)	**9**	34	**8**	33	**4**	21	**2**		**1**		**24**
Layer 9 (620-740 cm dt.)	**5**	50	**2**		**3**		**0**		**0**		**10**
Layer 10 (700-780 cm dt.)	**3**		**1**		**3**		**0**		**0**		**7**
Total	**39**	41	**23**	24	**28**	29	**5**	5	**1**	1	**96**

Table 4.4.2.3.19 Nature of the proximal edge of the other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The proximal edge of other choppers is rather similar to that of the side choppers and to a less extent of the end choppers, mostly cortical (40%: 39/96), then shaped by removals usually unifacial (31%: 30/96) and rarely bifacial (5/96), or in the form of a fracture (24%: 23/96, but 32% for the end choppers). There is only one proximal point **(Table 4.4.2.3.19)**.

7) Morpho-functional features of other choppers: Angle of the edges

7.1) Angle of right and left shaped edges

Right side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**1**		**4**		**4**		**0**		**9**
Layer 4 (340-700 cm dt.)	**1**		**3**		**3**		**1**		**8**
Layer 6 (470- 520 cm dt.)	**2**		**0**		**0**		**1**		**3**
Layer 7 (520- 580 cm dt.)	**2**		**0**		**1**		**1**		**4**
Layer 8 (580-720 cm dt.)	**3**		**6**		**5**		**1**		**15**
Layer 9 (620-740 cm dt.)	**0**		**2**		**1**		**1**		**4**
Layer 10 (700-780 cm dt.)	**0**		**0**		**0**		**1**		**1**
Total	**9**	20	**15**	34	**14**	32	**6**		**44**

Left side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**2**		**0**		**2**		**1**		**5**
Layer 4 (340-700 cm dt.)	**1**		**1**		**1**		**0**		**3**
Layer 6 (470- 520 cm dt.)	**0**		**2**		**0**		**1**		**3**
Layer 7 (520- 580 cm dt.)	**0**		**1**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**0**		**0**		**3**		**1**		**4**
Layer 9 (620-740 cm dt.)	**0**		**2**		**4**		**0**		**6**
Layer 10 (700-780 cm dt.)	**0**		**2**		**1**		**0**		**3**
Total	**3**		**8**	24	**11**	44	**3**		**25**

Table 4.4.2.3.20 Angle of the right and left shaped edges of the other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

When only the shaped edges of the other choppers are considered, it appears that the proportion of acute and oblique (or beveled) edges on the right side is higher than on the left side (55%: 24/44 against 44%: 11/25). Correlatively, the steep and steep-inverse sides are more frequent on the left side (56% against 45% for the right side) (**Table 4.4.2.3.20)**. These differences may not be statistically significant but when cumulated with the differences of cortical-non-shaped sides between right (30%) and left (44%) **(Table 4.4.2.3.17)**, they suggest a preference for tools with a steep side (cortical or shaped) on the left. This may be related to hand preference in the tool use but it must be noted that for the side choppers both sides were very similar in frequency of shaping and in angle of the shaped edge (see section 4.4.1.2).

7.2) Angle of distal shaped edge

Distal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**8**		**5**		**5**		**5**		**23**
Layer 4 (340-700 cm dt.)	**2**		**3**		**2**		**0**		**7**
Layer 6 (470- 520 cm dt.)	**2**		**1**		**0**		**1**		**4**
Layer 7 (520- 580 cm dt.)	**3**		**1**		**2**		**1**		**7**
Layer 8 (580-720 cm dt.)	**3**		**5**		**6**		**3**		**17**
Layer 9 (620-740 cm dt.)	**1**		**5**		**2**		**0**		**8**
Layer 10 (700-780 cm dt.)	**0**		**2**		**0**		**1**		**3**
Total	**19**	28	**22**	32	**17**	25	**11**	16	**69**

Table 4.4.2.3.21 Angle of distal shaped edge of the other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The distal edge of other choppers was found to be more often shaped than the lateral edges (**Table 4.4.2.3.21)** and moreover the shaping frequently results in acute (28%: 19/69) and oblique or medium-angled edges (32%: 22/69). These are slightly more common in distal position (60%) than in lateral positions (about 55% and 45%). However steep edges also occur (40%: 28/69) and reminds us that among the other choppers there is a group of steep choppers (n = 6) **(Table 4.4.2.3.18)**.

7.3) Angle of proximal shaped edge

Proximal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**3**		**5**		**3**		1		**12**
Layer 4 (340-700 cm dt.)	**0**		**0**		**1**		1		**2**
Layer 6 (470- 520 cm dt.)	**0**		**0**		**0**		2		**2**
Layer 7 (520- 580 cm dt.)	**1**		**1**		**2**		1		**5**
Layer 8 (580-720 cm dt.)	**0**		**3**		**1**		2		**6**
Layer 9 (620-740 cm dt.)	**0**		**3**		**0**		0		**3**
Layer 10 (700-780 cm dt.)	**1**		**1**		**1**		0		**3**
Total	**5**	15	**13**	39	**8**	24	**7**	21	**33**

Table 4.4.2.3.22 Angle of proximal shaped edge of the other choppers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The proximal edge of the other choppers is often shaped into a medium-angled (39%: 13/33) or acute edge (15%: 5/33). Shaping into a steep edge is rather common (45%: 15/33) **(Table 4.4.2.3.22)**, but for the steep morphology natural cortex or fracture were preferred (see **Table 4.4.2.3.19**). The location and morphology of the shaped edges makes the other choppers closer to the end choppers than to the side choppers. This corresponds to the higher frequency of the end choppers compared to the side choppers.

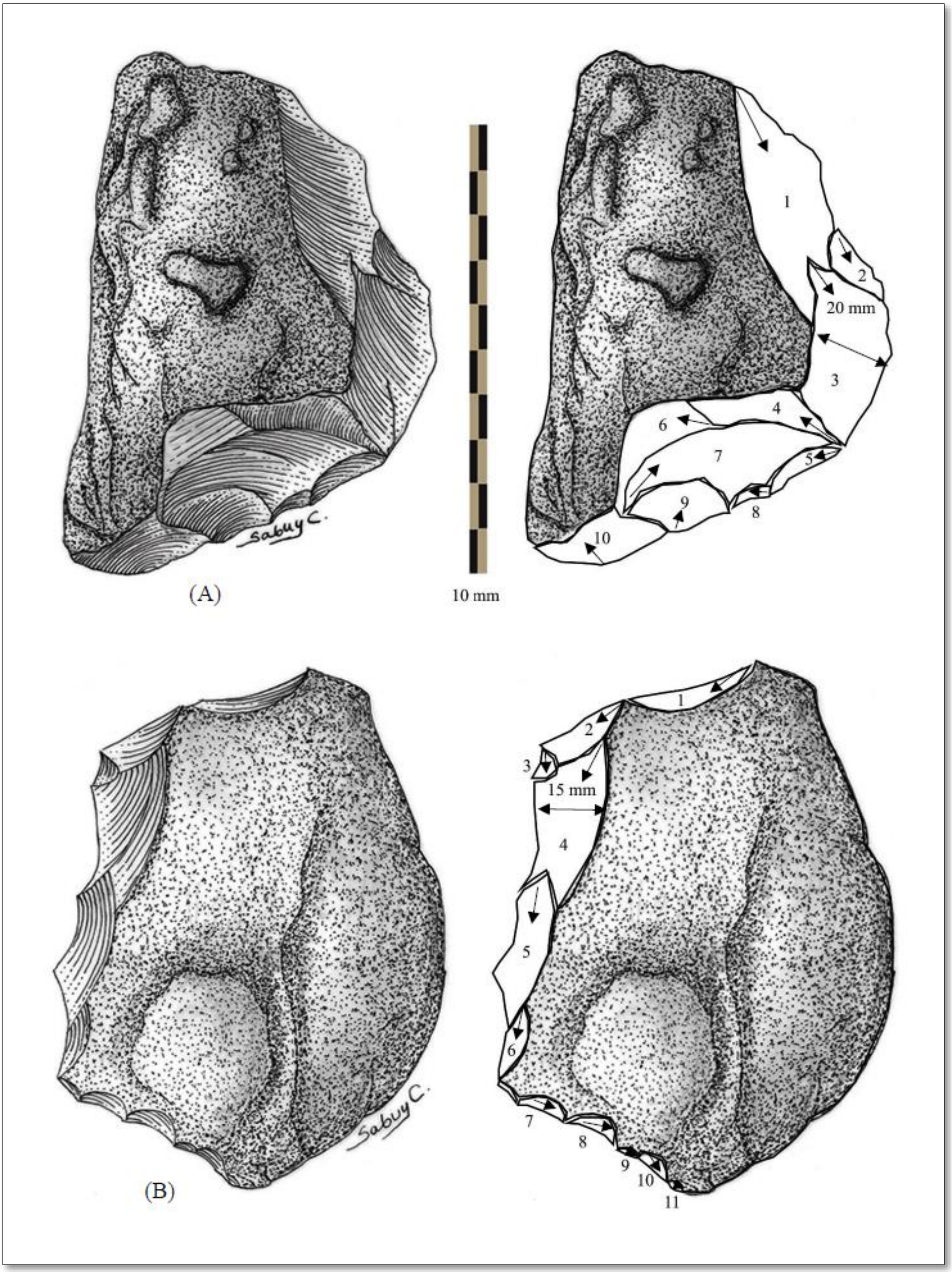


Figure 4.4.2.3.12 Main forms of other chopper found at Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4); a) multiple chopper, b) extended chopper (drawings T. Chitkament)

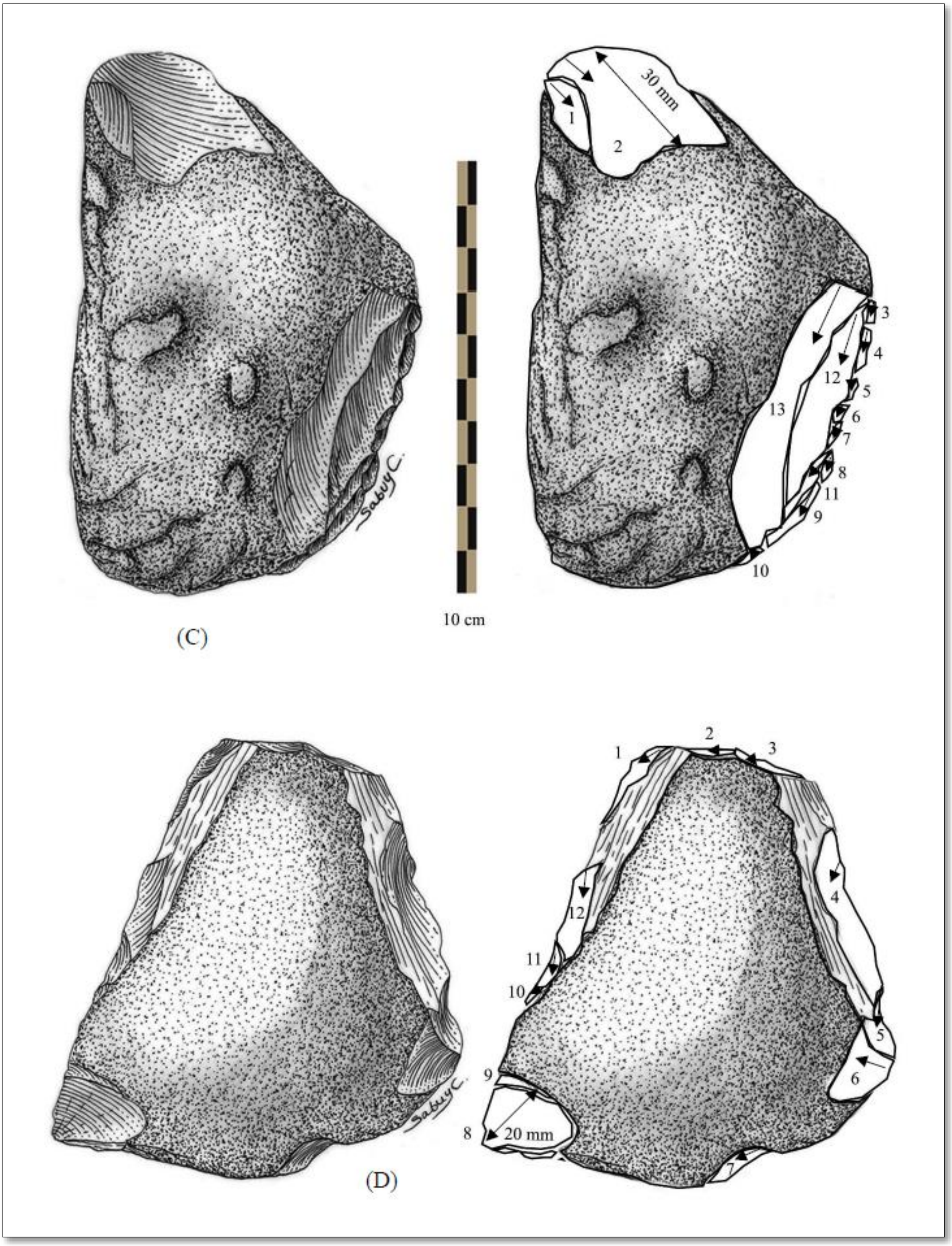


Figure 4.4.2.3.13 Main forms of other chopper found at Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4); c) multiple chopper (corner + side chopper), d) steep chopper (with indication of direction and number of removals and retouches; drawings T. Chitkament)

4.5 Analysis of small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4 & SEQ 1-2)

4.5.1 General features of the small tools

The tools have arbitrarily been classified into large tools or heavy-duty tools (often called core tools) and small tools or light-duty tools. The arbitrary boundary between both groups is 10 cm for the length (following Carbonell et al. 1999, in Rodriguez 2004; Kleindienst 1962). Therefore, all types of small tools are usually measuring less than 10 cm. Typical sumatraliths also occur among the small tools: these will be analyzed together with the larger ones, due to their obvious typological continuity whether more or less than 10 cm. It is to be noted that a group of the small tools is designed as "atypical small tools"; these artefacts bear some apparently intentional retouches, but they are impossible to classify into any particular type, even into partial scrapers.

A total of 411 small tools are present in the stratigraphic layers 3 to 10 of area 2, sectors S20W10 and S21W10 (4% of the entire lithic assemblage). The large majority of the small tools is in the upper layers 3 and 4, and the lowest number is in the bottom layer 10 (only 7 specimens). The scrapers are the most common small tools in all the layers, representing 46% (188/411) in average, with the highest proportion in the layer 7 (64%: 18/28) and the lowest in the layer 6 (26%: 8/31), (suggesting that these two layers may be parts of the same occupation level). In this group, the end scrapers are largely dominant, providing 94 items, while the other types are represented by less than 50 specimens, especially the corner, nosed scrapers and steep scrapers. Besides the scrapers, the small partial sumatraliths (unifacial) are providing 19% (80/411), with higher frequency in the layer 6 (35%: 11/31). For the other types of small tools, especially the unifacial discoids and the small ½ bifacial tools which are very few, the percentages are very small and therefore the proportions are statistically not significant **(Tables 4.5.1.1 and 4.5.1.2)**.

Small tools (Light-duty tools) **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Layer 3**		**Layer 4**		**Layer 5**		**Layer 6**		**Layer 7**		**Layer 8**		**Layer 9**		**Layer 10**		**Total**
Number (%)	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Beak scraper	**1**		**3**		**0**		**0**		**2**		**3**		**0**		**1**		**10**
Denticulate	**15**	12	**12**	10	**0**		**0**		**1**		**2**		**3**		**1**		**34**
Corner scraper	**0**		**2**		**0**		**0**		**0**		**0**		**0**		**0**		**2**
Double scraper	**7**	5	**4**		**1**		**0**		**1**		**1**		**1**		**1**		**16**
End scraper	**23**	18	**26**	21	**5**	43	**7**	23	**10**	36	**12**	28	**10**	26	**1**		**94**
Side scraper	**13**	10	**11**	9	**1**		**1**		**2**		**1**		**3**		**1**		**33**
Steep scraper	**2**		**3**		**0**		**0**		**0**		**2**		**1**		**0**		**8**
Nosed scraper	**0**		**0**		**0**		**0**		**0**		**0**		**1**		**0**		**1**
Multiple scraper	**7**	5	**7**	6	**0**		**0**		**3**		**4**		**3**		**0**		**24**
Pointed tool	**5**	4	**11**	9	**0**		**1**		**1**		**1**		**2**		**2**		**23**
Atypical small tool	**13**	10	**13**	11	**2**		**3**		**2**		**10**	23	**4**		**0**		**47**
Small sumatralith	**11**	9	**5**	4	**2**		**7**	23	**1**		**4**		**3**		**0**		**33**
Unifacial discoid	**2**		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**2**
1/2 Small sumatralith	**17**	13	**10**	8	**0**		**8**	26	**3**		**2**		**5**	13	**0**		**45**
1/4 Small sumatralith	**4**		**6**	5	**2**		**1**		**1**		**0**		**1**		**0**		**15**
3/4 Small sumatralith	**7**	5	**6**	5	**1**		**2**		**1**		**1**		**2**		**0**		**20**
1/2 Small bifacial tool	**1**		**2**		**0**		**1**		**0**		**0**		**0**		**0**		**4**
Total	**128**	31	**121**	29	**14**	3	**31**	8	**28**	7	**43**	10	**39**	10	**7**	2	**411**

Table 4.5.1.1 Distribution of small tool types (light-duty tools) in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Small tools (Light-duty tools) **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Scraper**		**Denticulate tool**		**Pointed tool**		**Atypical small tool**		**Small sumatralith**		**Unifacial discoid**		**Partial sumatralith (unifacial)**		**Partial sumatralith (bifacial)**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**53**	41	**15**	12	**5**	4	**13**	10	**11**	9	**2**		**28**	22	**1**		**128**
Layer 4 (340-700 cm dt.)	**56**	46	**12**	10	**11**	9	**13**	11	**5**	4	**0**		**22**	18	**2**		**121**
Layer 5 (400-470 cm dt.)	**7**	50	**0**		**0**		**2**		**2**		**0**		**3**		**0**		**14**
Layer 6 (470- 520 cm dt.)	**8**	26	**0**		**1**		**3**		**7**	23	**0**		**11**	35	**1**		**31**
Layer 7 (520- 580 cm dt.)	**18**	64	**1**		**1**		**2**		**1**		**0**		**5**	18	**0**		**28**
Layer 8 (580-720 cm dt.)	**23**	54	**2**		**1**		**10**	23	**4**		**0**		**3**		**0**		**43**
Layer 9 (620-740 cm dt.)	**19**	49	**3**		**2**		**4**		**3**		**0**		**8**	20	**0**		**39**
Layer 10 (700-780 cm dt.)	**4**		**1**		**2**		**0**		**0**		**0**		**0**		**0**		**7**
Total	**188**	46	**34**	8	**23**	6	**47**	11	**33**	8	**2**		**80**	19	**4**		**411**

Table 4.5.1.2 Distribution of the main categories of small tools in the stratigraphic sequence of sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4), area 2 of Tham Lod Rockshelter

Raw materials S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Gray sandstone**		**Black sandstone**		**Quartzite**		**Mudstone**		**Siliceous shale**		**Quartz**		**Haematite**		**Phtanite**		**Total**
Layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3	**119**	93	**7**	5	**0**		**0**		**2**		**0**		**0**		**0**		**128**
Layer 4	**112**	93	**3**		**2**		**0**		**3**		**0**		**1**		**0**		**121**
Layer 5	**14**	100	**0**		**0**		**0**		**0**		**0**		**0**		**0**		**14**
Layer 6	**29**	94	**2**		**0**		**0**		**0**		**0**		**0**		**0**		**31**
Layer 7	**26**	93	**2**		**0**		**0**		**0**		**0**		**0**		**0**		**28**
Layer 8	**36**	84	**2**		**1**		**1**		**1**		**2**		**0**		**0**		**43**
Layer 9	**35**	90	**2**		**0**		**2**		**0**		**0**		**0**		**0**		**39**
Layer 10	**4**		**1**		**0**		**0**		**1**		**0**		**0**		**1**		**7**
Total	**375**	91	**19**	5	**3**		**3**		**7**	2	**2**		**1**		**1**		**411**

Table 4.5.1.3 The raw materials of small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

As far as the raw material is concerned, the small tools are quite similar to large tools and to all the lithic assemblage; they are mostly in gray sandstone 91% (375/411), with a slight tendency to more diversity of rocks in the lower layers 8 to 10.

The other raw materials (less than 10% in the whole small tool group) are black sandstone, quartzite, mudstone, siliceous shale, quartz, haematite and phtanite (**Table 4.5.1.3)**.

Weight (gr.) S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4	**<100**	**101-200**	**201-300**	**301-400**	**401-500**	**501-600**	**601-700**	**701-800**	**>800**	**Total**
Layer 3 (320-640 cm dt.)	27	52	28	16	3	1	0	0	1	**128**
Layer 4 (340-700 cm dt.)	41	31	23	16	7	1	1	1	0	**121**
Layer 5 (400-470 cm dt.)	6	2	2	0	1	1	1	0	1	**14**
Layer 6 (470- 520 cm dt.)	9	7	7	5	1	1	1	0	0	**31**
Layer 7 (520- 580 cm dt.)	6	3	8	5	3	1	1	1	0	**28**
Layer 8 (580-720 cm dt.)	9	10	11	6	5	1	0	1	0	**43**
Layer 9 (620-740 cm dt.)	6	9	7	9	1	5	0	2	0	**39**
Layer 10 (700-780 cm dt.)	4	2	0	1	0	0	0	0	0	**7**
Total	**108**	**116**	**86**	**58**	**21**	**11**	**4**	**5**	**2**	**411**

Table 4.5.1.4 The weight (in gram) of small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

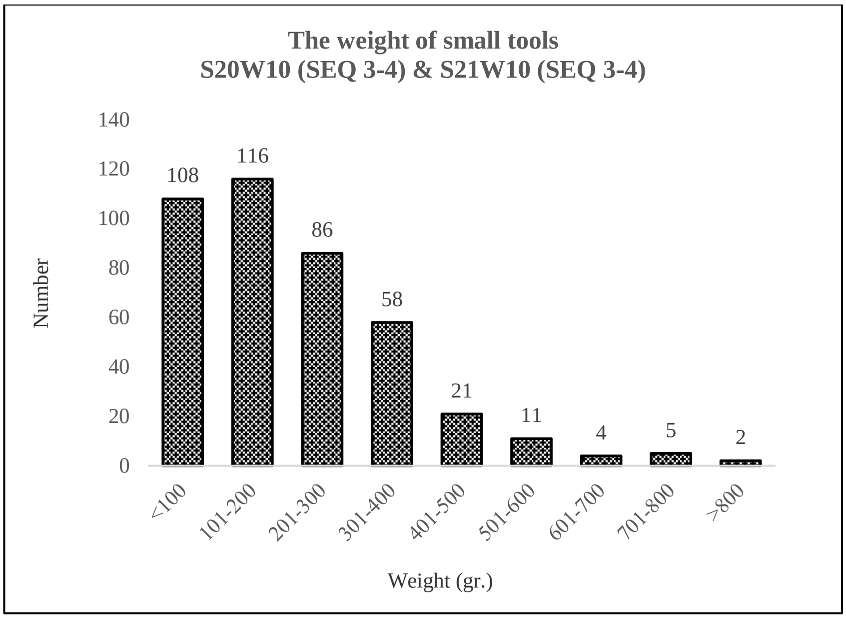


Figure 4.5.1.1 Distribution of the weight (in gram) of small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The weight of the diversified small tools follows a distribution which is explicitly unimodal with a main group between less than 100 and 300 g (310 tools: 75%). The other weight classes are gradually decreasing from 301 to more than 800 g, nearly 25%. It is to be noted that the weight classes of more than 0.5 kg are representing around 10% and the maximal weight (1000 g) is in the layer 5 **(Table 4.5.1.4, figure 4.5.1.1)**. By their weight, and also their dimensions, these small tools are complementary to the large tools which mainly weigh from 200 g to 1 kg.

4.5.2 Scrapers

A total of 188 scrapers (24% of all the tools) is analysed from the stratigraphic layers 3 to 10 of area 2, sectors S20W10 and S21W10. Their typology corresponds to various forms but all result from series of continuous retouch on one or several sides or corners. Different types are distinguished such as double scraper, corner scraper, end scraper, multiple scarper, side scraper, etc., mainly in the upper layers 3 to 4, where scrapers are outstandingly represented **(Tables 4.5.2.1 and 4.5.2.2)**.

1) General features of the scrapers

The end scrapers are overwhelming in these groups 50% (94/188), and in the middle layers 5 to 7, they are more significant, especially in the layer 6 (7/8 = 87%). Thereafter the side scrapers are in second position, representing 19% (33/188) but mostly occurring in the upper layers 3 and 4, (around 25%). The other types of scrapers like double scrapers, multiple scrapers, steep scrapers, corner scrapers, beak scarpers and nosed scrapers are very few **(Table 4.5.2.1, figure 4.5.2.1)**.

Scrapers S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Layer 3**		**Layer 4**		**Layer 5**		**Layer 6**		**Layer 7**		**Layer 8**		**Layer 9**		**Layer10**		**Total**
Number (%)	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
End scraper	**23**	43	**26**	47	**5**	72	**7**	87	**10**	56	**12**	52	**10**	53	**1**		**94** (50)
Side scraper	**13**	25	**11**	20	**1**		**1**		**2**		**1**		**3**		**1**		**33** (18)
Multiple scraper	**7**	13	**7**	13	**0**		**0**		**3**		**4**		**3**		**0**		**24** (13)
Double scraper	**7**	13	**4**		**1**		**0**		**1**		**1**		**1**		**1**		**16** (8)
Steep scraper	**2**		**3**		**0**		**0**		**0**		**2**		**1**		**0**		**8** (4)
Corner scraper	**0**		**2**		**0**		**0**		**0**		**0**		**0**		**0**		**2**
Beak scraper	**1**		**3**		**0**		**0**		**2**		**3**		**0**		**1**		**10** (5)
Nosed scraper	**0**		**0**		**0**		**0**		**0**		**0**		**1**		**0**		**1**
Total	**53**		**56**		**7**		**8**		**18**		**23**		**19**		**4**		**188**
Small tools S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4	**128**		**121**		**14**		**31**		**28**		**43**		**39**		**7**		**411**

Table 4.5.2.1 Distribution of the different types of scraper in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Scrapers S21W10 (SEQ 1-2)	**Layer 5**		**Layer 6**		**Layer 7**		**Total**
Number (%)	**N**	%	**N**	%	**N**	%	**N**
End scraper	**2**		**10**	56	**3**		**15** (63)
Side scraper	**0**		**3**		**0**		**3**
Multiple scraper	**0**		**2**		**0**		**2**
Steep scraper	**0**		**1**		**0**		**1**
Beak scraper	**0**		**1**		**0**		**1**
Nosed scraper	**1**		**1**		**0**		**2**
Total	**3**		**18**		**3**		**24**

Table 4.5.2.2 Distribution of the different types of scrapers in the stratigraphic layers 5 to 7 of Tham Lod Rockshelter, area 2 sectors S21W10 (SEQ 1-2)

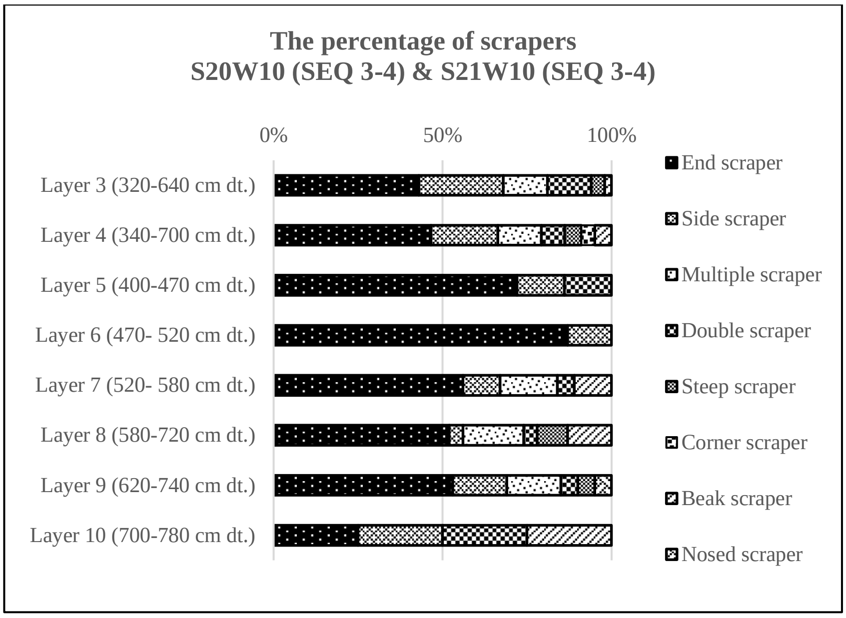


Figure 4.5.2.1 Distribution of the total number of scrapers in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Raw materials **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Gray sandstone**		**Black sandstone**		**Mudstone**		**Quartzite**		**Siliceous shale**		**Haematite**		**Phtanite**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**49**	92	**3**		**0**		**0**		**1**		**0**		**0**		**53**
Layer 4 (340-700 cm dt.)	**50**	89	**2**		**0**		**2**		**1**		**1**		**0**		**56**
Layer 5 (400-470 cm dt.)	**7**	100	**0**		**0**		**0**		**0**		**0**		**0**		**7**
Layer 6 (470- 520 cm dt.)	**8**	100	**0**		**0**		**0**		**0**		**0**		**0**		**8**
Layer 7 (520- 580 cm dt.)	**16**	89	**2**		**0**		**0**		**0**		**0**		**0**		**18**
Layer 8 (580-720 cm dt.)	**20**	87	**1**		**1**		**1**		**0**		**0**		**0**		**23**
Layer 9 (620-740 cm dt.)	**16**	84	**1**		**2**		**0**		**0**		**0**		**0**		**19**
Layer 10 (700-780 cm dt.)	**2**		**0**		**0**		**0**		**1**		**0**		**1**		**4**
Total	**168**	89	**9**	5	**3**		**3**		**3**		**1**		**1**		**188**

Table 4.5.2.3 The raw materials of scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Several types of raw materials were identified among the scrapers: gray sandstone, black sandstone, quartzite, mudstone, siliceous shale, haematite and phtanite. The large majority of the scrapers are in gray sandstone (168: 89% of the scrapers) with slightly lower frequencies in the lower layers, especially the bottom layer 10 (2/4). Correlatively, the other raw materials are hardly recovered in these sectors (**Table 4.5.2.3**).

2) Measurements

Measurement **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Length (mm)**	**Width (mm)**	**Thickness (mm)**	**Number of scrapers**
Layer 3 (320-340 cm dt.)	77	67	32	53
Layer 4 (340-400 cm dt.)	74	57	31	56
Layer 5 (400-470 cm dt.)	79	65	38	7
Layer 6 (470-520 cm dt.)	82	65	35	8
Layer 7 (520-580 cm dt.)	78	68	45	18
Layer 8 (580-620 cm dt.)	81	66	44	23
Layer 9 (620-700 cm dt.)	81	70	40	19
Layer 10 (700-720 cm dt.)	79	39	21	4
Average	**77**	**63**	**36**	**188**

Table 4.5.2.4 Average dimensions of scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The average length of the scrapers varies between 74 mm (layer 4) and 82 mm (layer 6). It corresponds to about half of the choppers length. However, the histogram representing the distribution of the scrapers length shows an almost continuous increase towards the higher values (**figure 4.5.2.2)**, suggesting a possible dimensional continuity between the scrapers and the choppers: maybe the arbitrary separation between small tools and large tools is not justified in this technological context.

The width of scrapers ranges between 57 mm (again layer 4) and 70 mm (layer 9), apart from the bottom layer 10, where scrapers are the narrowest in the series (39 mm). The average thickness is around 36 mm, and it is quite similar in all the layers, except for the layer 10, where scrapers are not only narrower but also thinner (21 mm). The average width and thickness of scrapers are about 3/4 lower than the corresponding measurements of the choppers, which can be understood as all the dimensions are broadly correlated **(Table 4.5.2.4, figures 4.5.2.5 & 4.5.2.6)**.

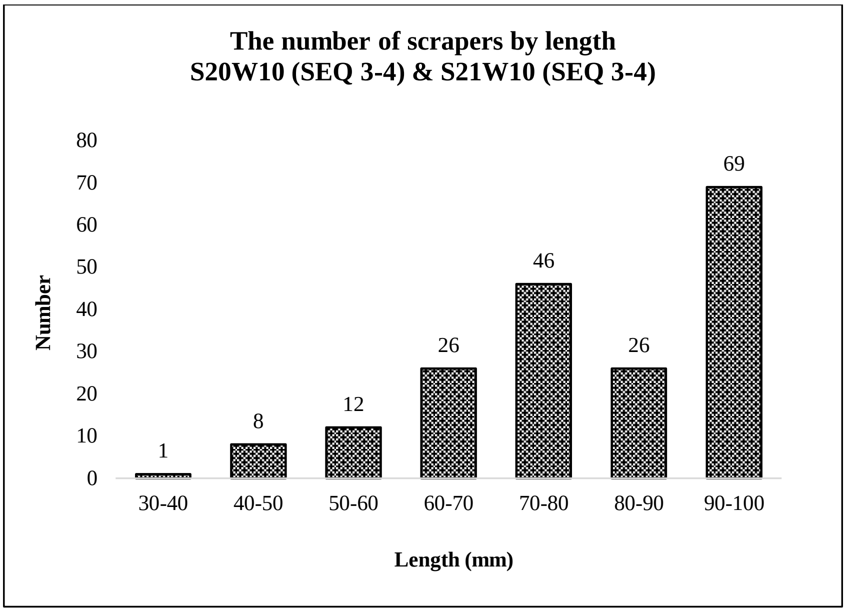


Figure 4.5.2.2 Distribution of the scrapers by length from Tham Lod Rockshelter area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

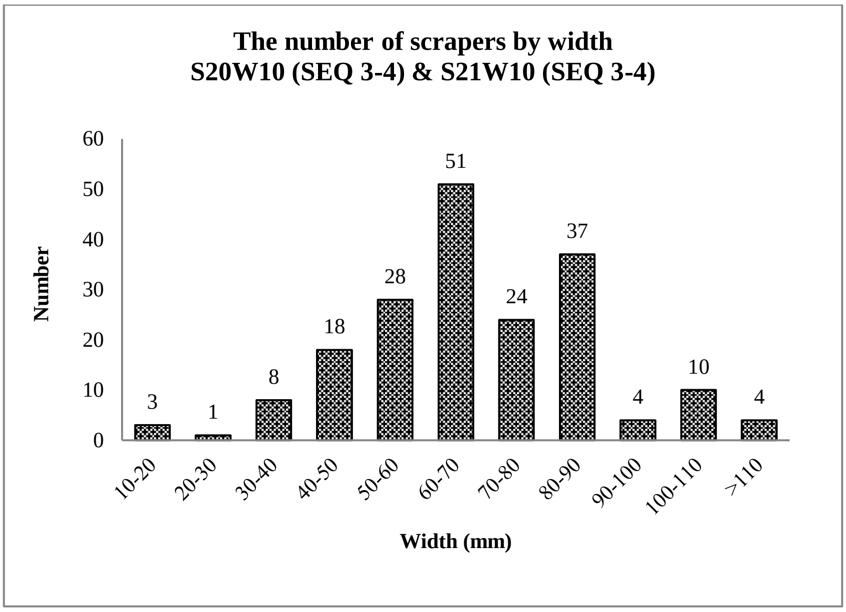


Figure 4.5.2.3 Distribution of the scrapers by width from Tham Lod Rockshelter area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

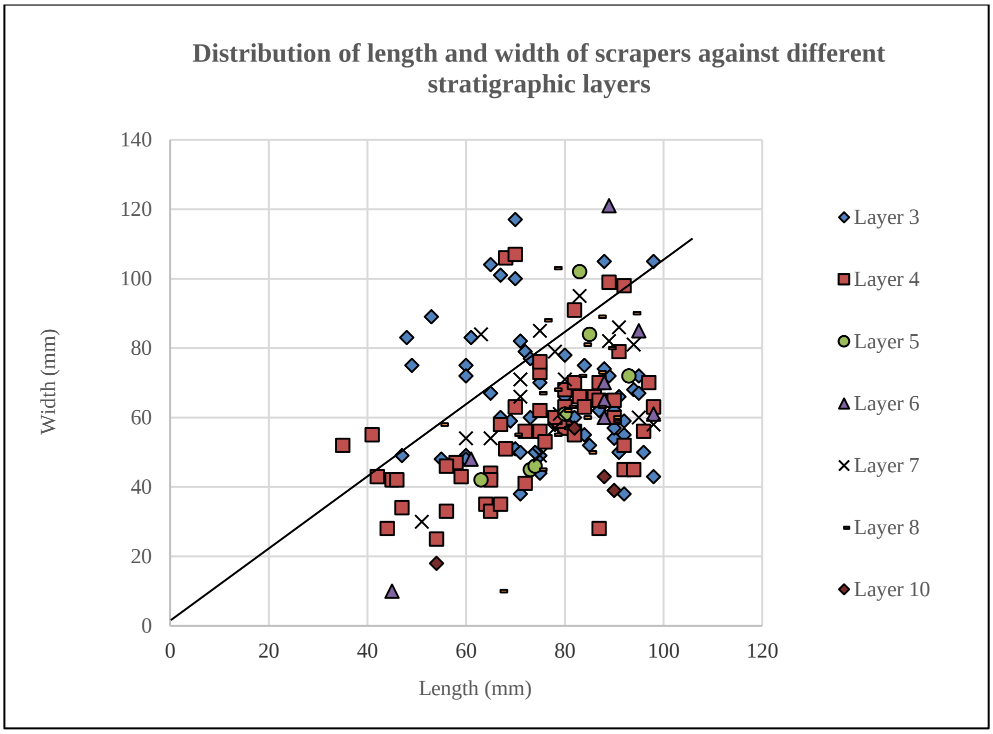


Figure 4.5.2.4 Scatter diagram length x width of the scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The length and the width of the scrapers seem to be slightly bimodal, with a main mode at 90-100 mm for the length and 60-70 mm for the width **(figures 4.5.2.2 and 4.5.2.3)**. The high concentration of scrapers closes to 100 mm long (and 80-90 mm wide), which is the maximal length for the so-called small tools or light-duty tools, actually questions the validity of this arbitrary limit between large and small tools. These biggest scrapers are probably in continuity with the choppers. Actually, the end choppers were found to be comprised of two groups according to their dimensions (**figures 4.4.2.1.1 and 4.4.2.1.2)** and the group of smaller choppers, less than 125 mm, may include the larger scrapers. Then, a smaller group of scrapers, around 70-80 mm in length and 60-70 mm for the width, may correspond to tools manufactured for lighter tasks. However, the scatter diagram **(figure 4.5.2.4)** does not provide any clear evidence of two groups.

The group of scrapers which are wider than long (above the diagonal of the graph) correspond to some specimens made on wide flakes (wider than long) and measured according to their technical orientation, while the other blanks are measured according to their morphological orientation (maximal dimension = length).

It is interesting to note that all these scrapers are quite larger than the blank flakes whose mean length and width are less than 45 mm **(Table 4.3.3)**. Obviously, the production of flakes / core reduction, if at all this operation was performed, was not intended to feed the pool of blanks for scrapers. Broken cobbles were preferred (see below).

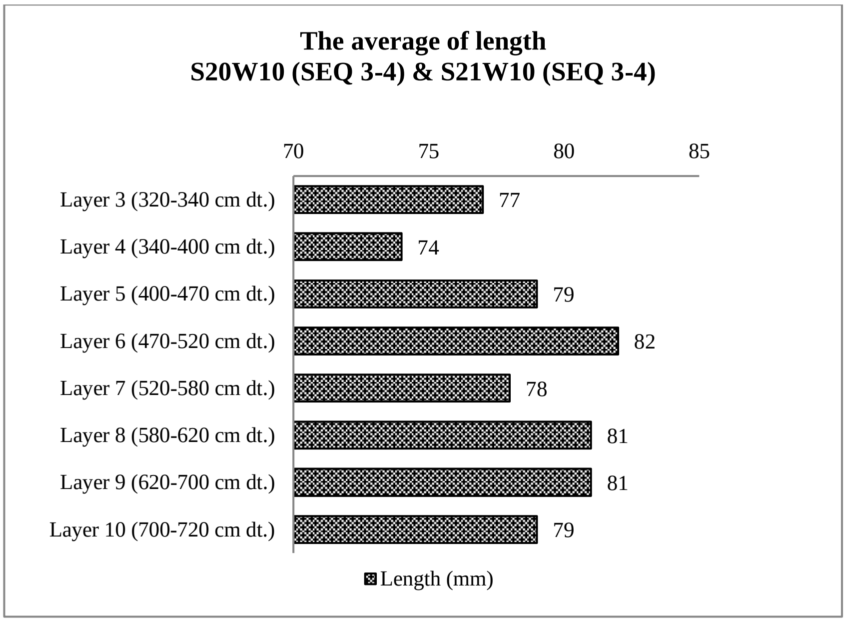


Figure 4.5.2.5 Distribution of the average length of the scrapers across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

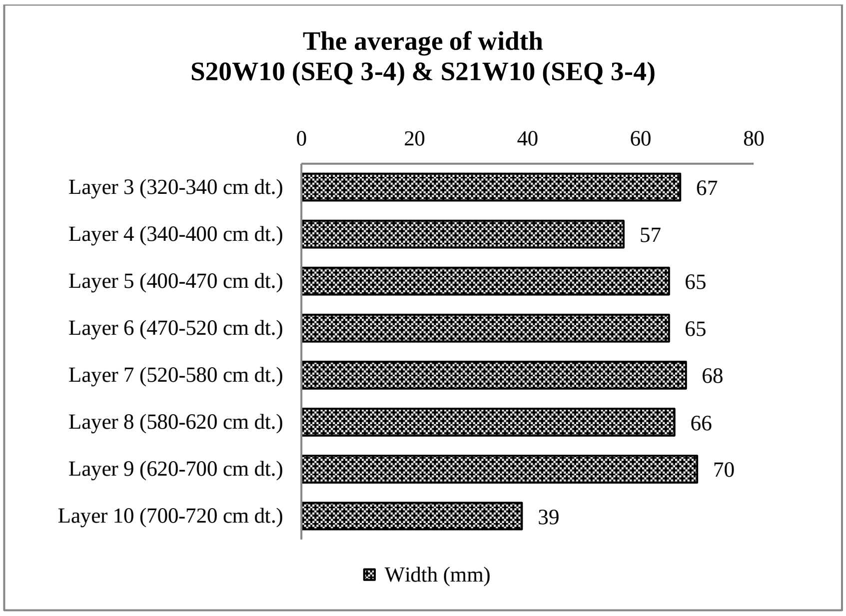


Figure 4.5.2.6 Distribution of the average width of the scrapers across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Weight (gr.) **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**<100**	**101-200**	**201-300**	**301-400**	**401-500**	**501-600**	**601-700**	**701-800**	**>800**	**Total**
Layer 3 (320-640 cm dt.)	5	21	17	8	0	1	0	0	1	**53**
Layer 4 (340-700 cm dt.)	20	11	8	9	5	1	1	1	0	**56**
Layer 5 (400-470 cm dt.)	3	0	1	0	0	1	1	0	1	**7**
Layer 6 (470- 520 cm dt.)	1	0	4	1	1	1	0	0	0	**8**
Layer 7 (520- 580 cm dt.)	2	1	6	3	3	1	1	1	0	**18**
Layer 8 (580-720 cm dt.)	2	3	7	5	5	1	0	0	0	**23**
Layer 9 (620-740 cm dt.)	2	5	2	5	0	3	1	1	0	**19**
Layer 10 (700-780 cm dt.)	2	2	0	0	0	0	0	0	0	**4**
Total	**37**	**43**	**45**	**31**	**14**	**9**	**4**	**3**	**2**	**188**

Table 4.5.2.5 The weight (in gram) of scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

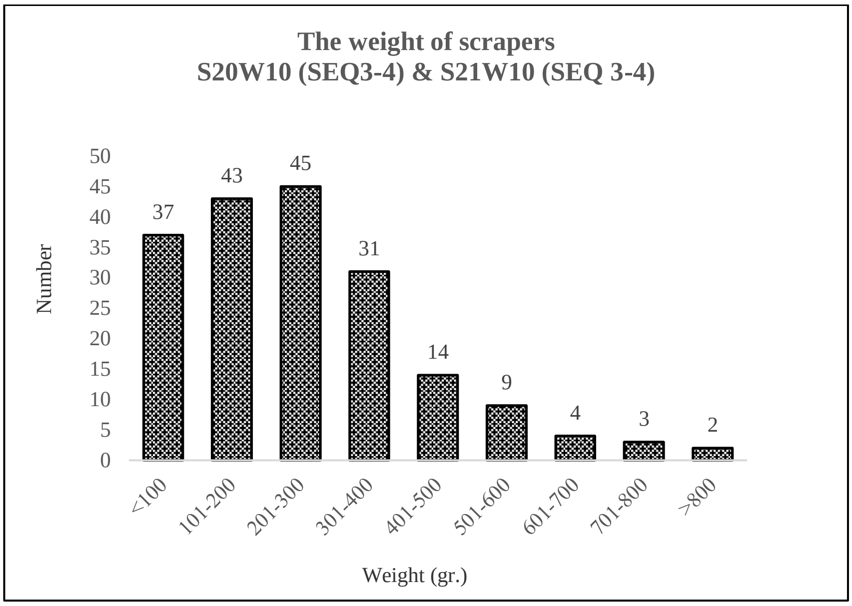


Figure 4.5.2.7 Distribution of the weight (in gram) of scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The weight distribution of the scrapers is similar to that of the small tool group. The main weight classes vary between less than 100 g and 400 g, but values are preponderant between 101 and 300 g (88 tools: 47%). The maximal weight is around 1000 g, represented by only one scraper found in the layer 5. The other weight classes, more than 500 g, represent around 10% only **(Table 4.5.2.5, figure 4.5.2.7)**.

3) Supports

More than half of the scrapers are made on broken cobbles (75/188: 40%) or boken pebbles (23/188: 12%). The flakes are in second position but far behind (29/188: 15%) and seem to be better represented in the lower layers 9 and 10. The split cobbles and the whole cobbles are almost as frequent as the flakes. The other supports are rare. It is interesting to note that in the layer 10 the 4 scrapers are made on flakes or fragments; none of them is made on broken cobble or pebble, which are the preferred supports in all the overlying layers **(Table 4.5.2.6, figure 4.5.2.8)**.

Supports **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Broken cobble**		**Whole cobble**		**Split cobble**		**Broken pebble**		**Whole pebble**		**Split pebble**		**Flake**		**Fragment**		**Total**
Layers	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**
Layer 3	**22**	42	**6**	11	**6**	11	**7**	13	**0**		**0**		**5**	9	**7**	13	**53**
Layer 4	**21**	38	**7**	13	**7**	13	**6**	11	**2**		**1**		**9**	16	**3**		**56**
Layer 5	**5**	71	**1**		**0**		**0**		**0**		**0**		**1**		**0**		**7**
Layer 6	**4**		**0**		**1**		**1**		**0**		**0**		**2**		**0**		**8**
Layer 7	**8**	44	**1**		**3**		**4**		**0**		**0**		**2**		**0**		**18**
Layer 8	**8**	35	**2**		**4**		**4**		**2**		**0**		**3**		**0**		**23**
Layer 9	**7**	37	**3**		**3**		**1**		**0**		**0**		**5**	26	**0**		**19**
Layer 10	**0**		**0**		**0**		**0**		**0**		**0**		**2**		**2**		**4**
Total	**75**	40	**20**	11	**24**	13	**23**	12	**4**		**1**		**29**	15	**12**	6	**188**

Table 4.5.2.6 The supports of scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

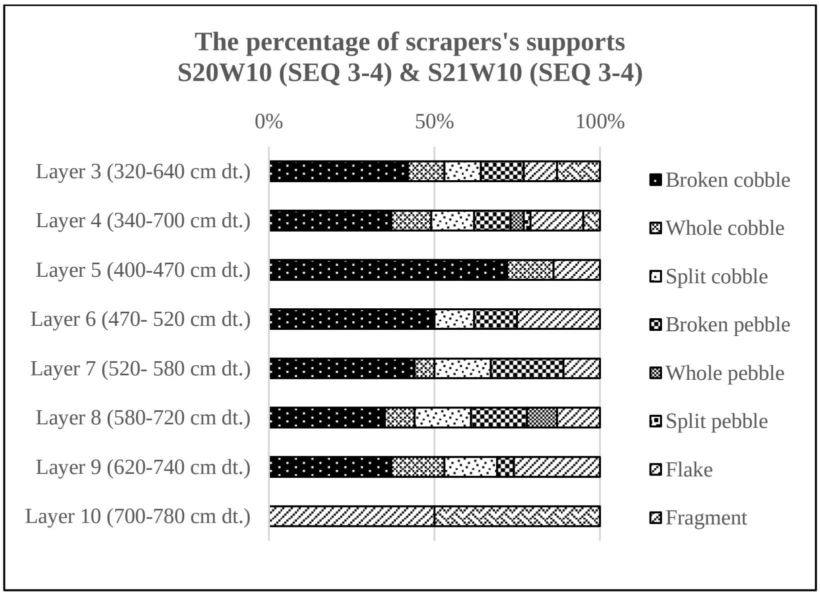


Figure 4.5.2.8 Distribution of the supports of scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4) General morphology of scrapers

4.1) Frontal view

Frontal view **S20W10 (SEQ 3-4) &** **S20W10 (SEQ 3-4)**	**Trape-zoidal**		**Irregular**		**Triangular**		**Half-oval**		**Oval**		**Pentagonal**		**Circular**		**D-shape**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-340 cm dt.)	**20**	38	**6**	11	**5**	9	**7**	13	**10**	19	**4**		**1**		**0**		**53**
Layer 4 (340-400 cm dt.)	**12**	22	**16**	29	**7**	12	**8**	14	**8**	13	**2**		**1**		**2**		**56**
Layer 5 (400-470 cm dt.)	**1**		**3**		**1**		**0**		**2**		**0**		**0**		**0**		**7**
Layer 6 (470-520 cm dt.)	**3**		**5**	62	**0**		**0**		**0**		**0**		**0**		**0**		**8**
Layer 7 (520-580 cm dt.)	**8**	44	**1**		**2**		**4**		**0**		**3**		**0**		**0**		**18**
Layer 8 (580-620 cm dt.)	**4**		**4**		**6**	26	**3**		**3**		**1**		**1**		**1**		**23**
Layer 9 (620-700 cm dt.)	**3**		**7**	37	**2**		**1**		**1**		**2**		**2**		**1**		**19**
Layer 10 (700-720 cm dt.)	**0**		**3**		**1**		**0**		**0**		**0**		**0**		**0**		**4**
Total	**51**	27	**45**	24	**24**	13	**23**	13	**24**	13	**12**	6	**5**	3	**4**	4/188	**188**

Table 4.5.2.7 The frontal view of scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4.2) Transversal view

Transversal view **S20W10 (SEQ 3-4) &** **S21W10 (SEQ 3-4)**	**Trape-zoidal**		**Irregular**		**Triangular**		**Oval**		**Half-oval**		**Pentagonal**		**D-shape**		**Circular**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-340 cm dt.)	**17**	32	**8**	15	**8**	15	**7**	13	**4**	6	**6**	11	**2**		**1**		**53**
Layer 4 (340-400 cm dt.)	**16**	29	**9**	16	**10**	18	**12**	21	**5**	9	**1**		**3**		**0**		**56**
Layer 5 (400-470 cm dt.)	**1**		**3**		**0**		**1**		**1**		**0**		**1**		**0**		**7**
Layer 6 (470-520 cm dt.)	**3**		**2**		**1**		**1**		**1**		**0**		**0**		**0**		**8**
Layer 7 (520-580 cm dt.)	**10**	56	**2**		**3**		**1**		**2**		**0**		**0**		**0**		**18**
Layer 8 (580-620 cm dt.)	**10**	44	**2**		**6**	26	**4**		**0**		**0**		**1**		**0**		**23**
Layer 9 (620-700 cm dt.)	**4**		**8**	29	**3**		**2**		**0**		**2**		**0**		**0**		**19**
Layer 10 (700-720 cm dt.)	**0**		**2**		**1**		**1**		**0**		**0**		**0**		**0**		**4**
Total	**61**	33	**36**	19	**32**	17	**29**	15	**13**	7	**9**	5	**7**	4	**1**		**188**

Table 4.5.2.8 The transversal view of scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The most common shape of the scrapers in frontal view is trapezoidal (26%: 49/188), especially in the layer 7 (44%: 8/18) or irregular (24%: 45/188) **(Table 4.5.2.7)**.

In transversal view, the trapezoidal shape (60/188: 32%) is the most significant as for the end and side choppers. The highest percentage is in the layer 7 (56%: 10/18), then in the layer 8, nearly 45% (10/23). Other transversal views are irregular, triangular or oval (20 to 15%) and the other shapes are hardly represented **(Table 4.5.2.8)**.

As the group of scrapers includes various sub-types, the characters of the shaping and the morpho-functional features are highly variable and closely related to the sub-types. It is not relevant to analyse them within the group of the scrapers all together. Therefore, only the two main sub-types of scrapers will be considered here: the side scrapers and the end scrapers.

4.5.2.1) End scrapers

5.1) Shaping of the end scrapers

5.1.1) Amount of cortex

- On the upper face

Amount of cortex **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**13**	57	**4**		**6**	26	**23**
Layer 4 (340-700 cm dt.)	**12**	46	**6**	23	**8**	31	**26**
Layer 5 (400-470 cm dt.)	**2**		**1**		**2**		**5**
Layer 6 (470- 520 cm dt.)	**6**	86	**0**		**1**		**7**
Layer 7 (520- 580 cm dt.)	**8**	80	**1**		**1**		**10**
Layer 8 (580-720 cm dt.)	**9**	75	**3**		**0**		**12**
Layer 9 (620-740 cm dt.)	**7**	70	**1**		**2**		**10**
Layer 10 (700-780 cm dt.)	**0**		**0**		**1**		**1**
Total	**57**	61	**16**	17	**21**	22	**94**

Table 4.5.2.9 Amount of cortex on upper face of the end scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The end scrapers are in majority "cortical dominant" 61% (57/94) on the upper face just like the choppers, in relation with the frequency of cobbles as supports. Therefore, the "non-cortical dominant" and "non-cortical" are much less; they are almost equal in proportion, nearly 20% each (**Table 4.5.2.9**).

- On the lower face

Amount of cortex **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Totally cortical**		**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**12**	52	**5**	22	**3**		**3**		**23**
Layer 4 (340-700 cm dt.)	**14**	54	**3**		**2**		**7**	27	**26**
Layer 5 (400-470 cm dt.)	**1**		**1**		**2**		**1**		**5**
Layer 6 (470- 520 cm dt.)	**3**		**1**		**1**		**2**		**7**
Layer 7 (520- 580 cm dt.)	**2**		**3**		**2**		**3**		**10**
Layer 8 (580-720 cm dt.)	**8**	67	**1**		**0**		**3**		**12**
Layer 9 (620-740 cm dt.)	**4**		**2**		**2**		**2**		**10**
Layer 10 (700-780 cm dt.)	**0**		**0**		**0**		**1**		**1**
Total	**44**	47	**16**	17	**12**	13	**22**	23	**94**

Table 4.5.2.10 Amount of cortex on lower face of the end scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Nearly half of the end scrapers (44/94: 47%) are “totally cortical” on the lower face, and the most important is in the layer 8 (8/12: 67%). Then the “non-cortical” lower face is second, representing about 23% (22/94). The “cortical dominant” and “non-cortical dominant” are less (30% for both) **(Table 4.5.2.10).**

5.1.2) Number of removals (shaping the tools)

- On the upper face

Number of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	1	2	3	4	5	6	7	8	9	>10 (~12)	Total number of end scrapers	Total number of removals	Average number of removals (total number of removals / total number of tools)
Layer 3	5	4	2	6	3	2	0	1	0	0	**23**	**78**	3,4
Layer 4	5	6	3	3	4	2	1	0	1	1	**26**	**98**	3,8
Layer 5	0	2	2	1	0	0	0	0	0	0	**5**	**14**	2,8
Layer 6	1	2	1	0	2	0	0	1	0	0	**7**	**26**	3,7
Layer 7	1	3	3	1	1	0	0	0	1	0	**10**	**34**	3,4
Layer 8	2	3	4	2	0	1	0	0	0	0	**12**	**34**	2,8
Layer 9	3	1	6	0	0	0	0	0	0	0	**10**	**23**	2,3
Layer 10	0	0	1	0	0	0	0	0	0	0	**1**	**3**	3,0
Total	**17**	**21**	**22**	**13**	**10**	**5**	**1**	**2**	**2**	**1**	**94**	**310**	3,3

Table 4.5.2.11 Number of removals on upper face of the end scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Even for the small tools, the intensity of shaping work is evaluated by counting only the removals longer than 5 mm. Most of the end scrapers (about 22-23%) display 2 or 3 removals, except in the upper layer 3 where a good number of scrapers have 4 removals. A single removal is also quite common on the end scrapers; this removal is associated with smaller retouch. It is interesting to note that the average number of removals shaping the end scrapers is around 3.3 in the whole sequence and does not show any significant trend along the stratigraphy **(Tables 4.5.2.11)**.

- *On the lower face*

Number of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	1	2	3	4	Total number of end scrapers with removals on the lower face	Total number of removals	Average number of removals (total number of removals / total number of tools)
Layer 3 (320-640 cm dt.)	1	0	2	1	**4**	**11**	2.8
Layer 4 (340-700 cm dt.)	0	3	0	0	**3**	**6**	2,0
Layer 5 (400-470 cm dt.)	1	0	0	0	**1**	**1**	1,0
Layer 6 (470- 520 cm dt.)	0	1	0	0	**1**	**2**	2,0
Layer 8 (580-720 cm dt.)	0	1	1	0	**2**	**5**	2,5
Layer 9 (620-740 cm dt.)	1	0	0	0	**1**	**1**	1,0
Total	**3**	**5**	**3**	**1**	**12**	**26**	2,2

Table 4.5.2.12 Number of removals on lower face of the end scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

On the lower face, end scrapers, like the choppers, are presenting a few removals, not more than 4 and usually 2. However, the large majority of end scrapers (68/94: 72%) have no removal at all on the lower face and are strictly unifacial **(Table 4.5.2.12)**.

5.1.3) Direction of removals

- On the upper face

Direction of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Unipolar**		**Bipolar-opposite**		**Bidirectional-orthogonal**		**Three-directions**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**19**	83	**3**		**1**		**0**		**23**
Layer 4 (340-700 cm dt.)	**20**	77	**5**	19	**0**		**1**		**26**
Layer 5 (400-470 cm dt.)	**5**	100	**0**		**0**		**0**		**5**
Layer 6 (470- 520 cm dt.)	**4**		**2**		**4**		**1**		**11**
Layer 7 (520- 580 cm dt.)	**5**	83	**0**		**0**		**1**		**6**
Layer 8 (580-720 cm dt.)	**11**	92	**1**		**0**		**0**		**12**
Layer 9 (620-740 cm dt.)	**9**	90	**1**		**0**		**0**		**10**
Layer 10 (700-780 cm dt.)	**0**		**1**		**0**		**0**		**1**
Total	**73**	78	**13**	14	**5**	5	**3**		**94**

Table 4.5.2.13 Direction of removals on upper face of the end scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

- On the lower face

Direction of removals **S20W10 (SEQ 3-4 & S21W10 (SEQ 3-4)**	**Unipolar**		**Bipolar-opposite**		**Bidirectional-orthogonal**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**0**		**0**		**4**
Layer 4 (340-700 cm dt.)	**2**		**1**		**0**		**3**
Layer 5 (400-470 cm dt.)	**1**		**0**		**0**		**1**
Layer 6 (470- 520 cm dt.)	**0**		**0**		**1**		**1**
Layer 8 (580-720 cm dt.)	**2**		**0**		**0**		**2**
Layer 9 (620-740 cm dt.)	**1**		**0**		**0**		**1**
Total	**10**	83	**1**		**1**		**12**

Table 4.5.2.14 Direction of removals on lower face of the end scrapers from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The end scrapers are of course shaped by unipolar unidirectional removals, but not exclusively (78%: 73/94 on the upper face, 83%: 10/12 on the lower face). Other patterns also occur such as “bidirectional-orthogonal” and even “three-directions” when the shaping slightly extends laterally or “bipolar-opposite” for the few end scrapers having one or two removal opposite to the main tool but not enough to be classified into the double scrapers **(Tables 4.5.2.13 and 4.5.2.14)**.

5.1.4) Length of the longest removal

- On the upper face

Longest removal S20W10 (SEQ 3-4) & S20W10 (SEQ 3-4)	**5-10**	**11-20**	**21-30**	**31-40**	**41-50**	**51-60**	**61-70**	Total number of end scrapers	Average maximal length (mm)
Layer 3 (320-640 cm dt.)	2	5	9	5	2	0	0	**23**	26
Layer 4 (340-700 cm dt.)	1	8	6	4	3	3	1	**26**	30
Layer 5 (400-470 cm dt.)	0	1	0	3	0	0	1	**5**	37
Layer 6 (470- 520 cm dt.)	0	2	2	1	2	0	0	**7**	28
Layer 7 (520- 580 cm dt.)	1	2	1	4	1	0	1	**10**	33
Layer 8 (580-720 cm dt.)	1	0	5	3	2	1	0	**12**	32
Layer 9 (620-740 cm dt.)	1	2	2	3	2	0	0	**10**	29
Layer 10 (700-780 cm dt.)	0	1	0	0	0	0	0	**1**	20
Total	**6**	**21**	**25**	**23**	**12**	**4**	**3**	**94**	

Table 4.5.2.15 Length of the longest removal (in mm) on upper face of end scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

- On the lower face

Longest length **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**7-10**	**11-20**	**31-40**	**41-50**	**51-60**	**71-80**	**81-90**	Total number of end scrapers	Average maximal length (mm)
Layer 3 (320-640 cm dt.)	1	3	0	0	0	0	0	**4**	14
Layer 4 (340-700 cm dt.)	0	0	2	1	0	0	0	**3**	36
Layer 5 (400-470 cm dt.)	0	0	0	0	1	0	0	**1**	57
Layer 6 (470- 520 cm dt.)	0	0	0	0	1	0	0	**1**	55
Layer 8 (580-720 cm dt.)	0	1	0	0	0	1	0	**2**	46
Layer 9 (620-740 cm dt.)	0	0	0	0	0	0	1	**1**	81
Total	**1**	**4**	**2**	**1**	**2**	**1**	**1**	**12**	

Table 4.5.2.16 Length of the longest removal on lower face of end scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

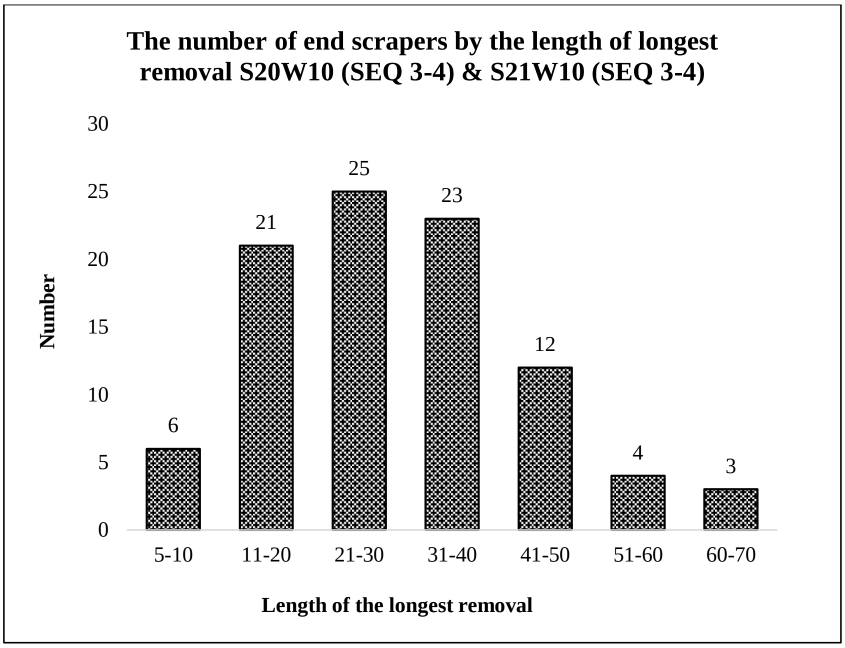


Figure 4.5.2.9 Distribution of length of the longest removal (in mm) on upper face of end scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The length of the longest removal (> 5 mm) on upper face of the end scrapers mainly varies between 10 and 40 mm, with an average of about 30 mm. No significant trend is visible along the stratigraphy. On the contrary, the few removals occurring on the lower face tend to decrease from bottom to top of the Pleistocene stratigraphy. These inverse removals are also much longer than the direct ones in all the lower and middle layers (10 to 5); therefore they can be suspected of belonging to another stage in the shaping process, possibly the preparation of the blank rather than the shaping of the end scraper **(Tables 4.5.2.15 and 4.5.2.16, figure 4.5.2.9)**.

6.1) Morpho-functional features of end scrapers: Nature of the edges

6.1.1) Nature of the lateral edges

Right side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**13**	57	**10**	43	**0**		**23**
Layer 4 (340-700 cm dt.)	**11**	42	**15**	58	**0**		**26**
Layer 5 (400-470 cm dt.)	**2**		**3**		**0**		**5**
Layer 6 (470- 520 cm dt.)	**1**		**4**		**2**		**7**
Layer 7 (520- 580 cm dt.)	**6**	60	**4**		**0**		**10**
Layer 8 (580-720 cm dt.)	**7**	59	**4**		**1**		**12**
Layer 9 (620-740 cm dt.)	**6**	60	**3**		**1**		**10**
Layer 10 (700-780 cm dt.)	**0**		**1**		**0**		**1**
Total	**46**	49	**44**	47	**4**	4	**94**

Left side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**11**	48	**12**	52	**0**		**23**
Layer 4 (340-700 cm dt.)	**14**	54	**11**	42	**1**		**26**
Layer 5 (400-470 cm dt.)	**2**		**3**		**0**		**5**
Layer 6 (470- 520 cm dt.)	**5**	71	**2**		**0**		**7**
Layer 7 (520- 580 cm dt.)	**6**	60	**4**		**0**		**10**
Layer 8 (580-720 cm dt.)	**9**	75	**0**		**3**		**12**
Layer 9 (620-740 cm dt.)	**4**		**4**		**2**		**10**
Layer 10 (700-780 cm dt.)	**0**		**0**		**1**		**1**
Total	**51**	54	**36**	38	**7**	8	**94**

Table 4.5.2.17 Nature of the lateral (right and left) edges of the end scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The end scrapers being usually not shaped on their lateral edges, these are either cortical, at least on one face, (around 50%) or resulting from a fracture (35 to 50%). The few other cases correspond to scrapers whose shaping extends on lateral edges (less than 10%; **Table 4.5.2.17**).

6.1.2) Nature of the distal edge

Distal side S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Retouch Unifacial**		**Retouch Bifacial**		**Pointed**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3	**1**		**2**		**16**	70	**0**		**3**		**1**		**0**		**23**
Layer 4	**2**		**3**		**18**	69	**1**		**2**		**0**		**0**		**26**
Layer 5	**2**		**0**		**2**		**1**		**0**		**0**		**0**		**5**
Layer 6	**0**		**2**		**5**	71	**0**		**0**		**0**		**0**		**7**
Layer 7	**1**		**0**		**9**	90	**0**		**0**		**0**		**0**		**10**
Layer 8	**1**		**0**		**11**	92	**0**		**0**		**0**		**0**		**12**
Layer 9	**2**		**7**	70	**0**		**0**		**0**		**1**		**0**		**10**
Layer 10	**0**		**0**		**0**		**0**		**0**		**0**		**1**		**1**
Total	**9**	10	**14**	15	**61**	65	**2**		**5**	5	**2**		**1**		**94**

Table 4.5.2.18 Nature of the distal edge of the end scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The distal edge of the end scrapers is usually unifacially shaped by removals (> 5 mm): 65% (61/94). Bifacial shaping is very rare. Some scrapers are shaped by retouch (< 5 mm), mostly unifacial. One of the end scrapers is pointed. In one fourth of the cases, the end scrapers are not shaped on their distal end but on their proximal end; then the distal end is a fracture or a cortical surface (**Table 4.5.2.18)**.

6.1.3) Nature of the proximal edge

Proximal side S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Retouch Unifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**7**	31	**9**	39	**5**	22	**1**		**1**		**23**
Layer 4 (340-700 cm dt.)	**11**	42	**6**	23	**6**	23	**1**		**2**		**26**
Layer 5 (400-470 cm dt.)	**1**		**2**		**2**		**0**		**0**		**5**
Layer 6 (470- 520 cm dt.)	**1**		**3**		**2**		**1**		**0**		**7**
Layer 7 (520- 580 cm dt.)	**1**		**7**	70	**1**		**1**		**0**		**10**
Layer 8 (580-720 cm dt.)	**8**	67	**2**		**2**		**0**		**0**		**12**
Layer 9 (620-740 cm dt.)	**5**	50	**3**		**2**		**0**		**0**		**10**
Layer 10 (700-780 cm dt.)	**0**		**0**		**0**		**0**		**1**		**1**
Total	**34**	36	**32**	34	**20**	22	**4**		**4**		**94**

Table 4.5.2.19 Nature of the proximal edge of the end scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

On the proximal edge of end scrapers, the same features as on the distal edge are observed: mainly unifacial removals, rarely bifacial and in some cases finer retouch without removal. Anyway, cortex or fracture are more common on the proximal edge (35% for each) **(Table 4.5.2.19)**. It is interesting to note that the end scrapers are mostly made on the distal edge, which is the narrowest (70% of the cases), compared to the proximal edge, which is wider.

7.1) Morpho-functional features of end scrapers: Angle of the edges

7.1.1) Angle of right and left edges

Right side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**8**	35	**9**	39	**4**		**2**		**23**
Layer 4 (340-700 cm dt.)	**8**	31	**8**	31	**7**	27	**3**		**26**
Layer 5 (400-470 cm dt.)	**1**		**2**		**1**		**1**		**5**
Layer 6 (470- 520 cm dt.)	**1**		**2**		**4**		**0**		**7**
Layer 7 (520- 580 cm dt.)	**0**		**3**		**4**		**3**		**10**
Layer 8 (580-720 cm dt.)	**3**		**6**	50	**3**		**0**		**12**
Layer 9 (620-740 cm dt.)	**3**		**3**		**3**		**1**		**10**
Layer 10 (700-780 cm dt.)	**0**		**1**		**0**		**0**		**1**
Total	**24**	25	**34**	36	**26**	28	**10**	11	**94**

Left side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**9**	39	**8**	35	**6**	26	**0**		**23**
Layer 4 (340-700 cm dt.)	**9**	35	**8**	31	**6**	23	**3**		**26**
Layer 5 (400-470 cm dt.)	**1**		**1**		**2**		**1**		**5**
Layer 6 (470- 520 cm dt.)	**1**		**1**		**4**		**1**		**7**
Layer 7 (520- 580 cm dt.)	**1**		**4**		**3**		**2**		**10**
Layer 8 (580-720 cm dt.)	**2**		**4**		**6**	50	**0**		**12**
Layer 9 (620-740 cm dt.)	**3**		**1**		**4**		**2**		**10**
Layer 10 (700-780 cm dt.)	**0**		**1**		**0**		**0**		**1**
Total	**26**	28	**28**	30	**31**	33	**9**	9	**94**

Table 4.5.2.20 Angle of right and left edges of the end scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The right and left edges of the end scrapers have quite similar morphologies. Although they are not shaped, their angle is often oblique (medium angled, for about 1/3 of the tools) and also quite often acute (about 1/4 and even more than 1/3 in the upper layers 3 and 4). Anyway, steep and steep-inverse edges are the most frequent, except in the upper layers **(Table 4.5.2.20)**.

7.1.2) Angle of distal shaped edge

As the distal or proximal edges of the end scrapers are supposed to be the active parts of the tools, if they are shaped, only the angle of the shaped edges are considered in the following two tables.

Distal side **S20W10 (SEQ 3-4) &** **S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**12**	60	**6**	30	**2**		**0**		**20**
Layer 4 (340-700 cm dt.)	**15**	71	**6**	29	**0**		**0**		**21**
Layer 5 (400-470 cm dt.)	**2**		**0**		**1**		**0**		**3**
Layer 6 (470- 520 cm dt.)	**2**		**2**		**0**		**1**		**5**
Layer 7 (520- 580 cm dt.)	**1**		**7**	78	**0**		**1**		**9**
Layer 8 (580-720 cm dt.)	**4**		**5**	45	**2**		**0**		**11**
Layer 9 (620-740 cm dt.)	**5**	63	**2**		**1**		**0**		**8**
Layer 10 (700-780 cm dt.)	**1**		**0**		**0**		**0**		**1**
Total	**41**	53	**28**	36	**6**	8	**2**		**78**

Table 4.5.2.21 Angle of the shaped distal edge of the end scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The distal edge of the end scrapers, when shaped, is mostly acute, especially in the upper layers and in layer 9, otherwise it is oblique; these two types of angle make up 90% of the distal edges. There are also a few cases of steep and steep-inverse end scrapers **(Table 4.5.2.21)**.

7.1.3) Angle of proximal shaped edge

Proximal side **S20W10 (SEQ 3-4) &** **S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**3**		**0**		**0**		**7**
Layer 4 (340-700 cm dt.)	**2**		**4**		**2**		**1**		**9**
Layer 5 (400-470 cm dt.)	**1**		**0**		**0**		**1**		**2**
Layer 6 (470- 520 cm dt.)	**0**		**0**		**2**		**1**		**3**
Layer 7 (520- 580 cm dt.)	**0**		**1**		**0**		**1**		**2**
Layer 8 (580-720 cm dt.)	**0**		**0**		**2**		**0**		**2**
Layer 9 (620-740 cm dt.)	**1**		**1**		**0**		**0**		**2**
Layer 10 (700-780 cm dt.)	**0**		**1**		**0**		**0**		**1**
Total	**8**		**10**		**6**		**4**		**28**

Table 4.5.2.22 Angle of the shaped proximal edge of the end scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The few scrapers shaped on their proximal end are not as markedly acute or oblique/medium as their counterparts shaped on the distal end: these relatively sharp tools represent around 2/3 of the proximal end scrapers. The other ones are steep or steep-inverse **(Table 4.5.2.22)**. However, out of the 10 proximal shaped edges forming a rather steep angle, 5 are actually opposite to a distal shaped edge, rather acute. In these cases, the proximal shaping may contribute to create or improve the prehensive function of the proximal part while the transformative function is at the distal end.

4.5.2.2) Side scrapers

5.2) Shaping of the side scrapers

5.2.1) Amount of cortex

- On the upper face

Amount of cortex **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortical dominant** (>50% cortical)		**Non cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**5**	38	**4**		**4**		**13**
Layer 4 (340-700 cm dt.)	**7**	64	**2**		**2**		**11**
Layer 5 (400-470 cm dt.)	**1**		**0**		**0**		**1**
Layer 6 (470- 520 cm dt.)	**0**		**0**		**1**		**1**
Layer 7 (520- 580 cm dt.)	**0**		**1**		**1**		**2**
Layer 8 (580-720 cm dt.)	**0**		**1**		**0**		**1**
Layer 9 (620-740 cm dt.)	**1**		**2**		**0**		**3**
Layer 10 (700-780 cm dt.)	**1**		**0**		**0**		**1**
Total	**15**	46	**10**	30	**8**	24	**33**

Table 4.5.2.23 Amount of cortex on upper face of the side scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The upper face of the side scrapers is mostly “cortical dominant”, especially in the layer 4 (65%: 7/11, whereas in the whole sequence it is 46%: 15/33), then the “non-cortical dominant” comes in second position, representing 30% (10/33). The “non- cortical” provides almost 25% of the side scrapers **(Table 4.5.2.23)**.

- *On the lower face*

Amount of cortex	**Totally cortical**		**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**8**	62	**1**		**2**		**2**		**13**
Layer 4 (340-700 cm dt.)	**6**	55	**3**		**1**		**1**		**11**
Layer 5 (400-470 cm dt.)	**0**		**0**		**1**		**0**		**1**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**0**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**1**		**1**		**0**		**0**		**2**
Layer 8 (580-720 cm dt.)	**0**		**0**		**0**		**1**		**1**
Layer 9 (620-740 cm dt.)	**1**		**0**		**1**		**1**		**3**
Layer 10 (700-780 cm dt.)	**1**		**0**		**0**		**0**		**1**
Total	**18**	55	**5**	15	**5**	15	**5**	15	**33**

Table 4.5.2.24 Amount of cortex on lower face of the side scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Like the end scrapers, the side scrapers are “totally cortical” on their lower face in half of the cases, even more (55%: 18/33). The “cortical-dominant”, “non-cortical dominant” and “non-cortical” are in equal proportion (15%) **(Table 4.5.2.24)**.

5.2.2) Number of removals (shaping the tools)

- On the upper face

Number of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**>10 (~12)**	Total number of side scrapers	Total number of removals	Average number of removals (total number of removals / total number of tools)
Layer 3	0	2	2	2	6	0	1	0	0	**13**	**55**	4,2
Layer 4	1	2	2	0	1	2	0	1	2	**11**	**60**	5,5
Layer 5	0	1	0	0	0	0	0	0	0	**1**	**2**	2,0
Layer 6	0	0	1	0	0	0	0	0	0	**1**	**3**	3,0
Layer 7	0	1	1	0	0	0	0	0	0	**2**	**5**	2,5
Layer 8	0	1	0	0	0	0	0	0	0	**1**	**2**	2,0
Layer 9	0	0	0	2	0	0	0	0	1	**3**	**20**	6,7
Layer 10	1	0	0	0	0	0	0	0	0	**1**	**1**	1,0
Total	**2**	**7**	**6**	**4**	**7**	**2**	**1**	**1**	**3**	**33**	**148**	4,5

Table 4.5.2.25 Number of removals on upper face of the side scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The number of removals shaping the side scrapers on their upper face is remarkably higher in the upper layers 3 and 4 (more than 4 removals), where actually 70% of the side scrapers are found. It is also high for the 3 side scrapers from the layer 9. In the other layers these tools are usually shaped by 2 or 3 removals **(Tables 4.5.2.25)**.

- On the lower face

Number of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	1	2	3	4	Total number of side scrapers with removals on the lower face	Total number of removals	Average number of removals (total number of removals / total number of tools)
Layer 3 (320-640 cm dt.)	1	0	0	1	**2**	**5**	2,5
Layer 4 (340-700 cm dt.)	0	1	0	0	**1**	**2**	2,0
Layer 8 (580-720 cm dt.)	0	0	1	0	**1**	**3**	3,0
Layer 9 (620-740 cm dt.)	1	0	0	0	**1**	**1**	1,0
Total	**2**	**1**	**1**	**1**	**5**	**11**	2,2

Table 4.5.2.26 Number of removal on lower face of the side scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

A few side scrapers also have some removals on the lower face but they are not bifacial **(Table 4.5.2.26)**.

5.2.3) Direction of removals

- On the upper face

Direction of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Unipolar**		**Bipolar-opposite**		**Bidirectional-orthogonal**		**Three-directions**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**10**	77	**2**		**0**		**1**		**13**
Layer 4 (340-700 cm dt.)	**8**	73	**2**		**1**		**0**		**11**
Layer 5 (400-470 cm dt.)	**1**		**0**		**0**		**0**		**1**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**0**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**2**		**0**		**0**		**0**		**2**
Layer 8 (580-720 cm dt.)	**0**		**1**		**0**		**0**		**1**
Layer 9 (620-740 cm dt.)	**2**		**1**		**0**		**0**		**3**
Layer 10 (700-780 cm dt.)	**1**		**0**		**0**		**0**		**1**
Total	**25**	76	**6**	18	**1**		**1**		**33**

Table 4.5.2.27 Direction of removals on upper face of the side scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

- On the lower face

Direction of removals S20W10 (SEQ 3-4 & S21W10 (SEQ 3-4)	**Unipolar**		**Bipolar-opposite**		**Bidirectional-orthogonal**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**1**		**1**		**0**		**2**
Layer 4 (340-700 cm dt.)	**1**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**0**		**0**		**1**		**1**
Layer 9 (620-740 cm dt.)	**1**		**0**		**0**		**1**
Total	**3**		**1**		**1**		**5**

Table 4.5.2.28 Direction of removals on lower face of the side scrapers from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

As expected the removals shaping the side scrapers are mostly unidirectional (76%: 25/33). The few other patterns of removals, as already noticed, correspond to shaping extending on the edges adjacent to the main lateral one **(Tables 4.5.2.27 and 4.5.2.28)**.

5.2.4) Length of the longest removal

- On the upper face

Longest removal S20W10 (SEQ 3-4) & S20W10 (SEQ 3-4)	**6-10**	**11-20**	**21-30**	**31-40**	**41-50**	**61-70**	Total number of side scrapers	Average maximal length (mm)
Layer 3 (320-640 cm dt.)	2	4	5	2	0	0	**13**	21
Layer 4 (340-700 cm dt.)	2	2	3	4	0	0	**11**	24
Layer 5 (400-470 cm dt.)	0	0	1	0	0	0	**1**	25
Layer 6 (470- 520 cm dt.)	0	1	0	0	0	0	**1**	19
Layer 7 (520- 580 cm dt.)	0	1	1	0	0	0	**2**	17
Layer 8 (580-720 cm dt.)	0	0	0	0	1	0	**1**	41
Layer 9 (620-740 cm dt.)	1	0	0	1	0	1	**3**	37
Layer 10 (700-780 cm dt.)	0	0	0	0	0	1	**1**	65
Total	**5**	**8**	**10**	**7**	**1**	**2**	**33**	

Table 4.5.2.29 Length of the longest removal (in mm) on upper face of side scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

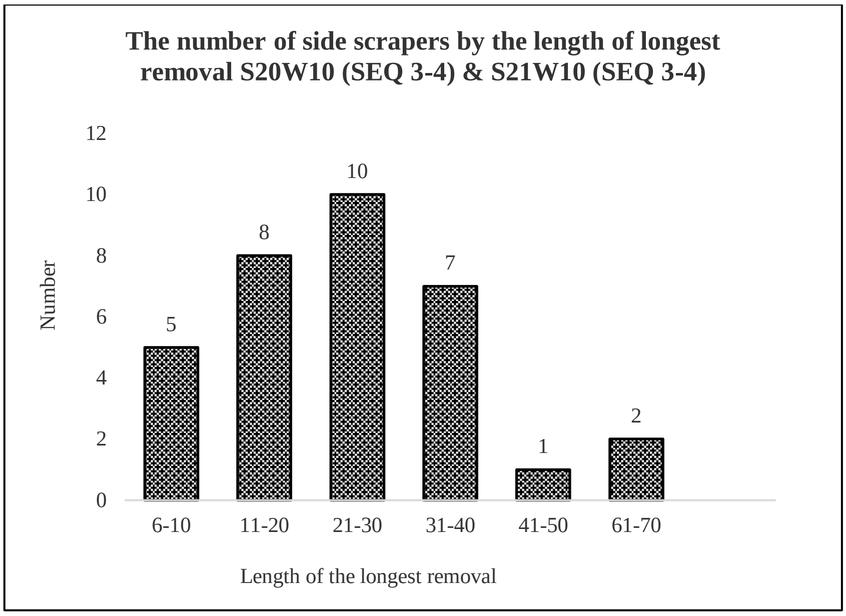


Figure 4.5.2.10 Distribution of length of the longest removal (in mm) on upper face of side scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

- *On the lower face*

Longest length **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4**	**6-10**	**11-20**	**21-30**	**61-70**	Total number of side scrapers	Average maximal length (mm)
Layer 3 (320-640 cm dt.)	1	0	0	1	**2**	35
Layer 4 (340-700 cm dt.)	0	1	0	0	**1**	15
Layer 8 (580-720 cm dt.)	0	1	0	0	**1**	12
Layer 9 (620-740 cm dt.)	0	0	1	0	**1**	25
Total	**1**	**2**	**1**	**1**	**5**	

Table 4.5.2.30 Length of the longest removal on lower face of side scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The lengths of the longest removal of the side scrapers follow a normal distribution around an average of 20-30 mm **(Table 4.5.2.29, figure 4.5.2.10)**. This is the same average for the end scrapers. Moreover, it is also the same for the group of choppers showing smaller removals, as this measurement, length of the longest removal, appears to have a slightly bimodal distribution, especially for the side choppers but also for the end choppers (**figures 4.4.2.1.9 and 4.4.2.2.10)**

6.2) Morpho-functional features of side scrapers: Nature of the edges

6.2.1) Nature of the lateral edges

Right side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Retouch Unifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**0**		**3**		**8**	62	**0**		**2**		**13**
Layer 4 (340-700 cm dt.)	**1**		**0**		**6**	55	**1**		**3**		**11**
Layer 5 (400-470 cm dt.)	**0**		**1**		**0**		**0**		**0**		**1**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**0**		**0**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**1**		**1**		**0**		**0**		**0**		**2**
Layer 8 (580-720 cm dt.)	**0**		**1**		**0**		**0**		**0**		**1**
Layer 9 (620-740 cm dt.)	**1**		**1**		**1**		**0**		**0**		**3**
Layer 10 (700-780 cm dt.)	**0**		**0**		**1**		**0**		**0**		**1**
Total	**4**	12	**7**	21	**16**	49	**1**		**5**	15	**33**

Left side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Retouch Unifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**3**		**6**	46	**2**		**2**		**13**
Layer 4 (340-700 cm dt.)	**7**	64	**2**		**2**		**0**		**11**
Layer 5 (400-470 cm dt.)	**0**		**0**		**1**		**0**		**1**
Layer 6 (470- 520 cm dt.)	**0**		**0**		**1**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**0**		**1**		**1**		**0**		**2**
Layer 8 (580-720 cm dt.)	**0**		**0**		**1**		**0**		**1**
Layer 9 (620-740 cm dt.)	**2**		**0**		**0**		**1**		**3**
Layer 10 (700-780 cm dt.)	**1**		**0**		**0**		**0**		**1**
Total	**13**	40	**9**	27	**8**	24	**3**	9	**33**

Table 4.5.2.31 Nature of the lateral (right and left) edges of the side scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The right and left edges of the side scrapers are quite different: shaping mostly occurs on the right edge (67%: 22/33) and only on third of the scrapers are shaped on the left edge. When not shaped, edges are usually cortical or made by a fracture. The proportion of fractures is the same on the left and right sides. Shaping is always unifacial except in one case in layer 4, and it is mostly produced by removals, while finer retouches are less common **(Table 4.5.2.31)**.

6.2.2) Nature of the distal edge

Distal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**7**	57	**5**	38	**1**		**13**
Layer 4 (340-700 cm dt.)	**7**	64	**3**		**1**		**11**
Layer 5 (400-470 cm dt.)	**1**		**0**		**0**		**1**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**1**		**2**
Layer 8 (580-720 cm dt.)	**1**		**0**		**0**		**1**
Layer 9 (620-740 cm dt.)	**2**		**1**		**0**		**3**
Layer 10 (700-780 cm dt.)	**0**		**1**		**0**		**1**
Total	**20**	61	**10**	30	**3**		**33**

Table 4.5.2.32 Nature of the distal edge of the side scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The distal edge of the side scrapers is mostly cortical (61%; 20/33), or then fractured shape is the second, representing (30%; 10/33). On a few scrapers the removals extend from the side to the distal edge (less than 10%) (**Table 4.5.2.32)**.

6.2.3) Nature of the proximal edge

Proximal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Retouch Unifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**3**		**9**	69	**0**		**1**		**13**
Layer 4 (340-700 cm dt.)	**5**	45	**6**	55	**0**		**0**		**11**
Layer 5 (400-470 cm dt.)	**0**		**1**		**0**		**0**		**1**
Layer 6 (470- 520 cm dt.)	**0**		**1**		**0**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**0**		**2**		**0**		**0**		**2**
Layer 8 (580-720 cm dt.)	**1**		**0**		**0**		**0**		**1**
Layer 9 (620-740 cm dt.)	**1**		**1**		**1**		**0**		**3**
Layer 10 (700-780 cm dt.)	**1**		**0**		**0**		**0**		**1**
Total	**11**	33	**20**	61	**1**		**1**		**33**

Table 4.5.2.33 Nature of the proximal edge of the side scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The proximal edge of side scrapers is the opposite of that of the side choppers, mostly resulting from a fracture (61%; 20/33). However, nearly one third of the end scrapers (33%; 11/33) are cortical and a few proximal edges show some removals **(Table 4.5.2.33)**

7.2) Morpho-functional features of side scrapers: Angle of the edges

7.2.1) Angle of right and left edges

Right side **S20W10 (SEQ 3-4) &** **S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**5**	39	**3**		**5**	38	**0**		**13**
Layer 4 (340-700 cm dt.)	**5**	46	**3**		**2**		**1**		**11**
Layer 5 (400-470 cm dt.)	**0**		**0**		**0**		**1**		**1**
Layer 6 (470- 520 cm dt.)	**0**		**0**		**1**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**0**		**0**		**2**		**0**		**2**
Layer 8 (580-720 cm dt.)	**0**		**0**		**0**		**1**		**1**
Layer 9 (620-740 cm dt.)	**0**		**2**		**0**		**1**		**3**
Layer 10 (700-780 cm dt.)	**1**		**0**		**0**		**0**		**1**
Total	**11**	34	**8**	24	**10**	30	**4**		**33**

Left side **S20W10 (SEQ 3-4) &** **S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**3**		**5**	38	**4**		**1**		**13**
Layer 4 (340-700 cm dt.)	**4**		**2**		**5**	46	**0**		**11**
Layer 5 (400-470 cm dt.)	**0**		**1**		**0**		**0**		**1**
Layer 6 (470- 520 cm dt.)	**0**		**1**		**0**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**0**		**1**		**2**
Layer 8 (580-720 cm dt.)	**1**		**0**		**0**		**0**		**1**
Layer 9 (620-740 cm dt.)	**2**		**0**		**0**		**1**		**3**
Layer 10 (700-780 cm dt.)	**0**		**1**		**0**		**0**		**1**
Total	**11**	34	**10**	30	**9**	27	**3**		**33**

Table 4.5.2.34 Angle of right and lefts edges of the side scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The right and left edges of the side scrapers are quite similar to shape, mostly acute (sharp angled, 34%: 11/33), but they are well considered on the oblique or steep (medium and open angled, approximately 56% in the whole sequence). The fewer shaped edge is steep-inverse, around 10-12% **(Table 4.5.2.34)**.

7.2.2) Angle of distal edge

Distal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**7**	54	**2**		**3**		**1**		**13**
Layer 4 (340-700 cm dt.)	**1**		**6**	55	**4**		**0**		**11**
Layer 5 (400-470 cm dt.)	**1**		**0**		**0**		**0**		**1**
Layer 6 (470- 520 cm dt.)	**0**		**1**		**0**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**1**		**0**		**2**
Layer 8 (580-720 cm dt.)	**0**		**0**		**0**		**1**		**1**
Layer 9 (620-740 cm dt.)	**1**		**0**		**1**		**1**		**3**
Layer 10 (700-780 cm dt.)	**1**	100	**0**		**0**		**0**		**1**
Total	**12**	37	**9**	27	**9**	27	**3**		**33**

Table 4.5.2.35 Angle of distal edge of the side scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The distal edge of side scrapers is rather acute (sharp angled, nearly 75% in the total layers), but may be mostly cortical shaped. Then, the oblique and steep (medium to open angled) are equal on the distal edge, almost 27% each. However, there is also steep-inverse edge among these side scrapers, for 10% **(Table 4.5.2.35)**.

7.2.3) Angle of proximal edge

Proximal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**3**		**5**	38	**1**		**13**
Layer 4 (340-700 cm dt.)	**1**		**2**		**8**	9	**0**		**11**
Layer 5 (400-470 cm dt.)	**0**		**0**		**0**		**1**		**1**
Layer 6 (470- 520 cm dt.)	**0**		**0**		**0**		**1**		**1**
Layer 7 (520- 580 cm dt.)	**0**		**1**		**1**		**0**		**2**
Layer 8 (580-720 cm dt.)	**0**		**0**		**0**		**1**		**1**
Layer 9 (620-740 cm dt.)	**0**		**2**		**1**		**0**		**3**
Layer 10 (700-780 cm dt.)	**0**		**1**		**0**		**0**		**1**
Total	**5**	15	**9**	27	**15**	46	**4**		**33**

Table 4.5.2.36 Angle of proximal edge of the side scrapers from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Opposite to their shaped edge, the side scrapers usually are more steep (46%: 15/33) on the proximal edge, but both of them are more oblique or steep (medium or opened angled; 73% in the whole sequence). This morphology is more frequent on the fractured shape or cortex (**Table 4.5.2.36)**.

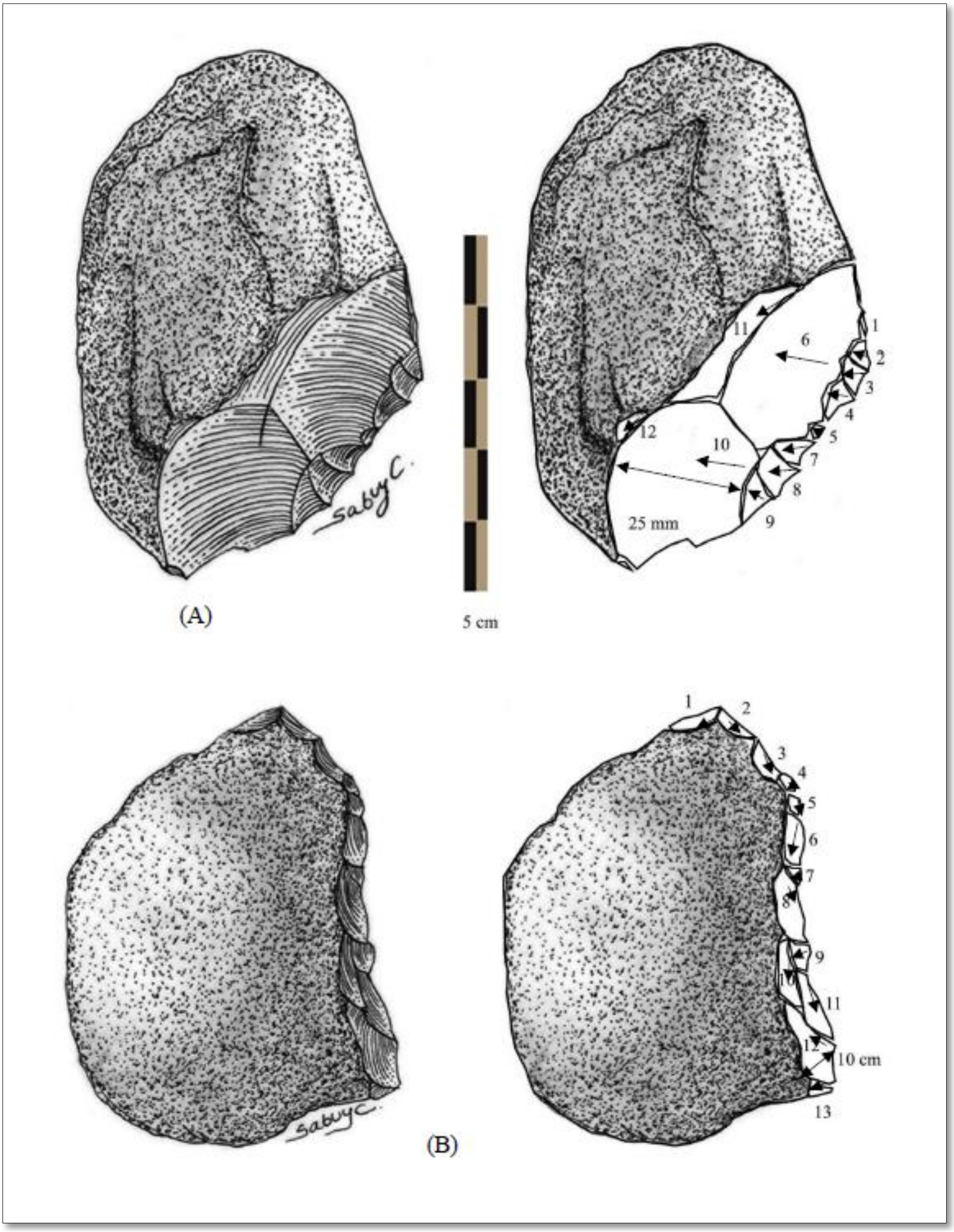


Figure 4.5.2.11 Main forms of scrapers found at Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4); a) end scraper, b) side scraper (illustrating the direction and number of removals and retouches; drawings T. Chitkament)

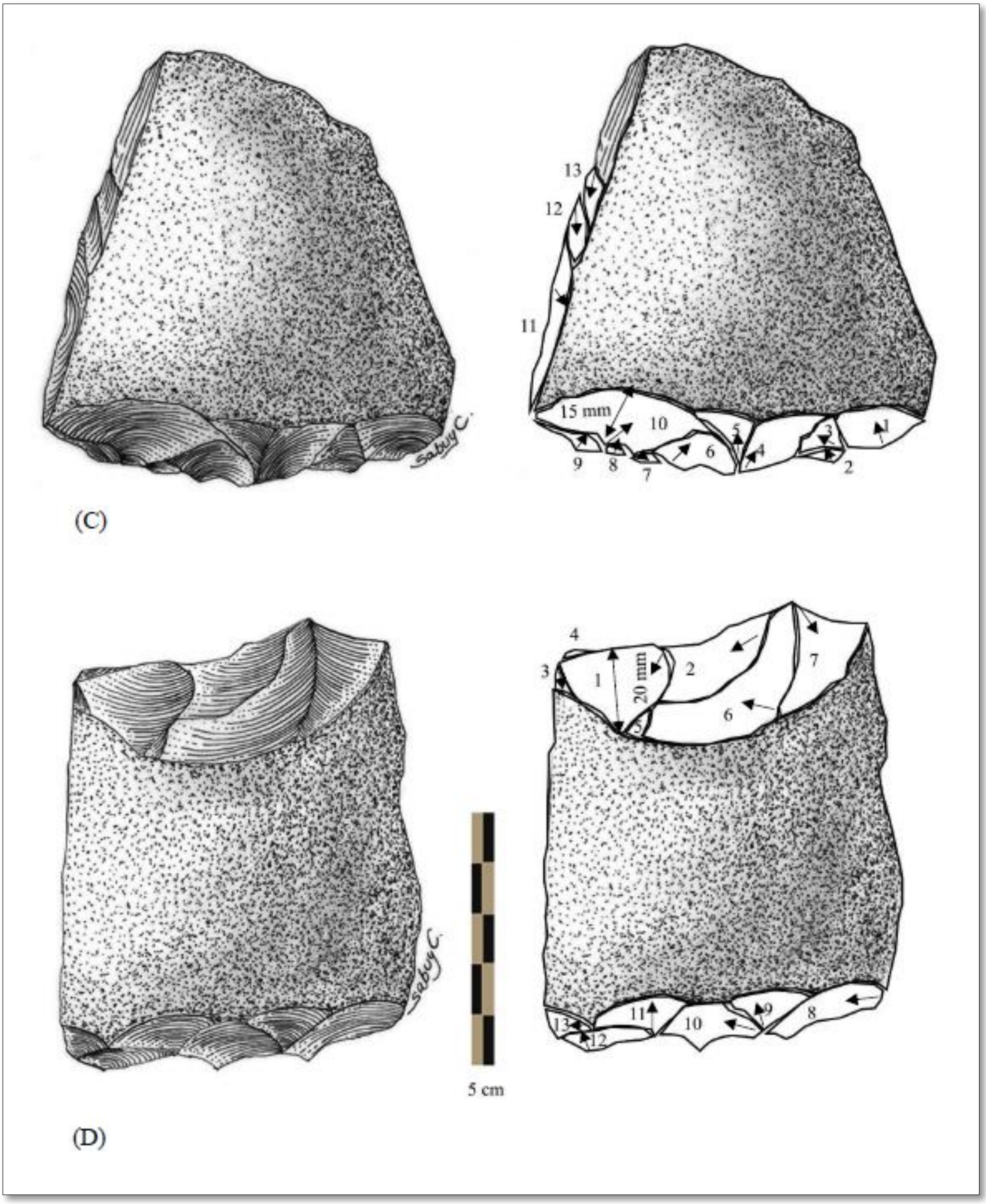


Figure 4.5.2.12 Main forms of scrapers found at Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4); c) steep scraper, d) double scraper (illustrating the direction and number of removals and retouches; drawings T. Chitkament)

4.5.3 Denticulates

1) General features of the Denticulates

With a total of 34 items, the denticulates represent about 8% of the small tools in the layers 3 and 4 then 7 to 10 (they are absent in layers 5 and 6), of area 2, sectors S20W10 and S21W10. Most of the numbers are not statistically representative, except in the upper layers 3 and 4, where they are around 10-12%. The large majority of denticulates are found from the sector S20W10 and only two specimens (in layers 4 and 7) are found in the sector S21W10 **(Table 4.5.3.1)**.

All of them are in gray sandstone in the whole sequence; other rocks have not been used to make denticulates.

Denticulates	**Layer 2**		**Layer 3**		**Layer 4**		**Layer 5**		**Layer 6**		**Layer 7**		**Layer 8**		**Layer 9**		**Layer 10**		**Total**
Numbers (%)	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
S20W10 (SEQ 3-4)	**10**		**15**	13	**11**	11	**0**		**0**		**0**		**2**		**3**		**1**		**42**
S21W10 (SEQ 3-4)	**0**		**0**		**1**		**0**		**0**		**1**		**0**		**0**		**0**		**2**
S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**10**		**15**	12	**12**	10	**0**		**0**		**1**		**2**		**3**		**1**		**34** (8%)
Small tools S20W10 (SEQ3-4) & S21W10 (SEQ 3-4)	**41**		**128**		**121**		**14**		**31**		**28**		**43**		**39**		**7**		**411**

Table 4.5.3.1 Total number of denticulates in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

2) Measurements

Measurement S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Length (mm)**	**Width (mm)**	**Thickness (mm)**	**Number of denticulates**
Layer 3 (320-640 cm dt.)	75	48	28	15
Layer 4 (340-700 cm dt.)	73	46	29	12
Layer 7 (520- 580 cm dt.)	95	83	42	1
Layer 8 (580-720 cm dt.)	87	63	25	2
Layer 9 (620-740 cm dt.)	62	44	30	3
Layer 10 (700-780 cm dt.)	73	36	23	1
Average	**74**	**49**	**29**	**34**

Table 4.5.3.2 Average dimensions of the denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The average dimensions of denticulates are a little smaller than those of the scrapers, but larger (bigger) than the atypical small tools. The average length and width are graded between 62 and 87 mm for the length and between 36 and 63 mm for the width. The average thickness is 29 mm, with variations between 23 and 42 mm. The highest values are found on the single denticulate from the layer 7: 95 mm for the length and 83 mm for the width and 42 for the thickness **(Table 4.5.3.2, figures 4.5.3.4 & 4.5.3.5)**.

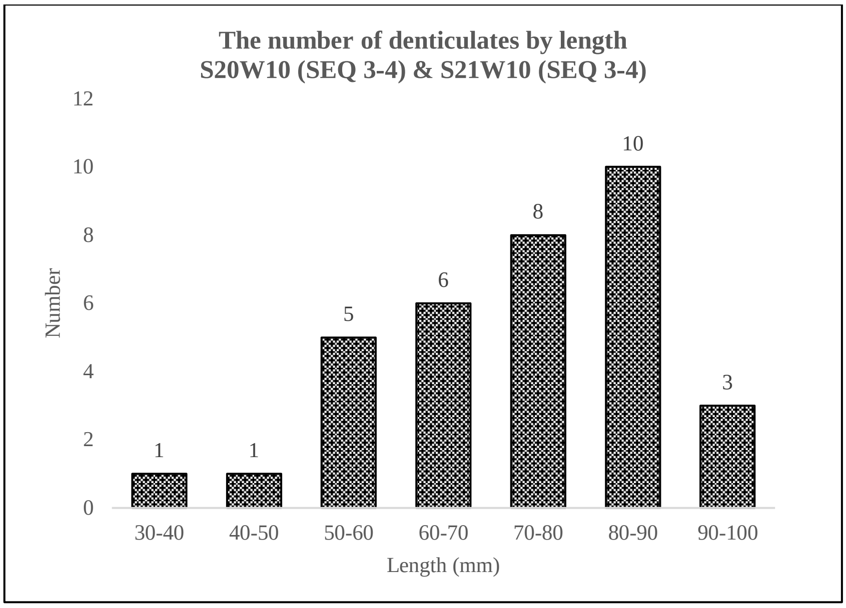


Figure 4.5.3.1 Distribution of the length of the denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

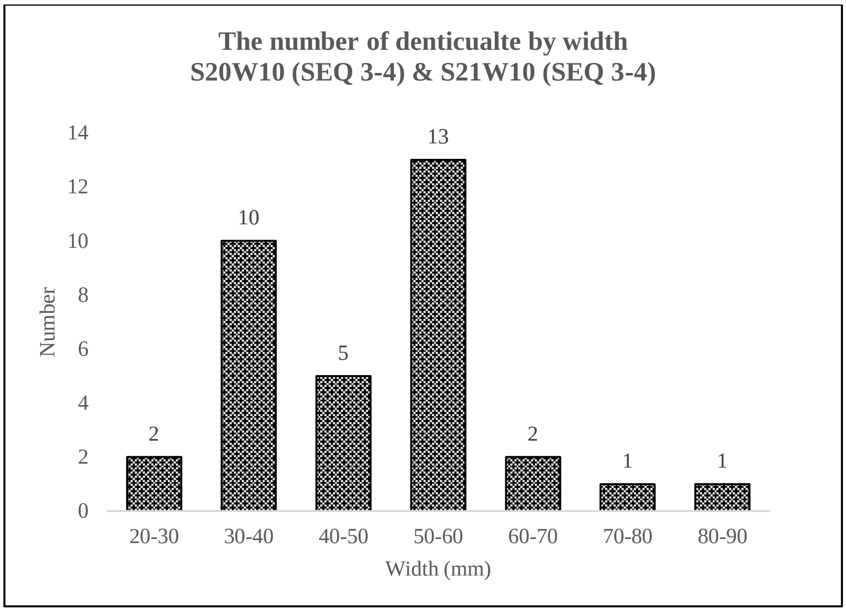


Figure 4.5.3.2 Distribution of the width of the denticulates from Tham Lod Rockshelter area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

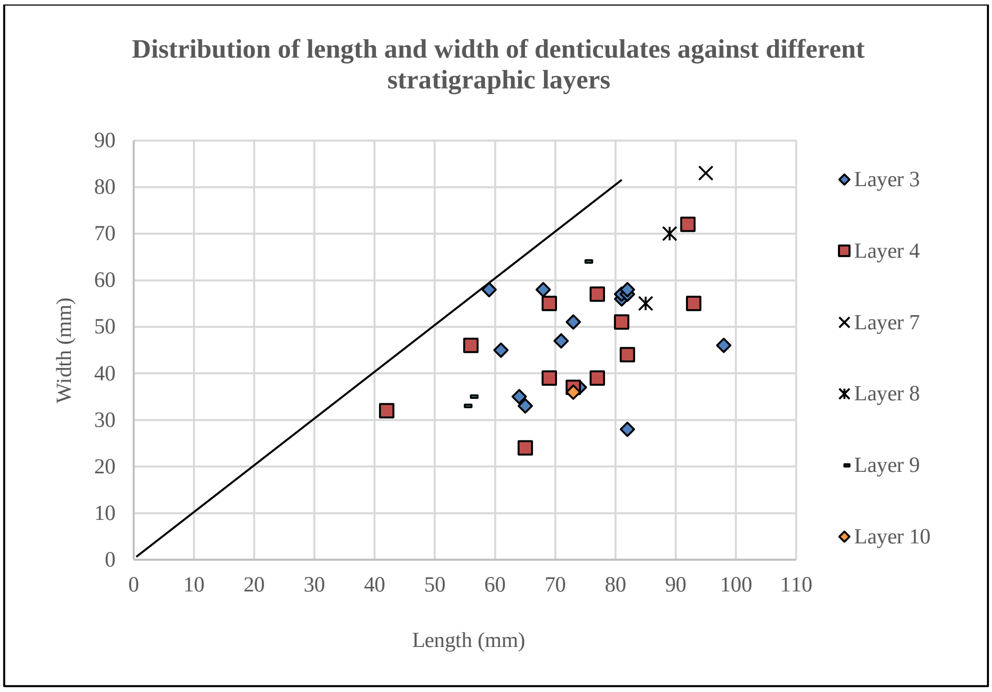


Figure 4.5.3.3 Scatter diagram length x width of the denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

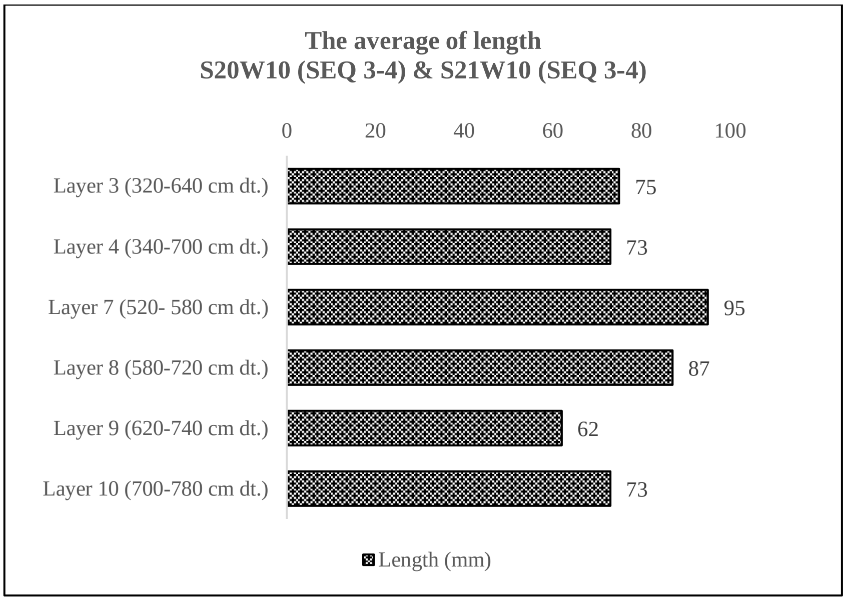


Figure 4.5.3.4 Distribution of the average length of the denticulates across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

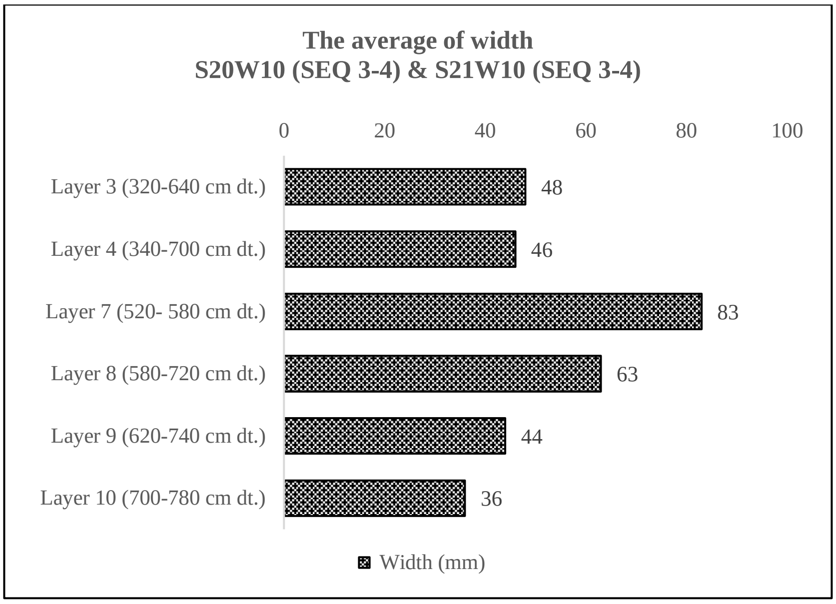


Figure 4.5.3.5 Distribution of the average width of the denticulates across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Weight (gr.) **S20W10 (SEQ 3-4) &** **S21W10 (SEQ 3-4)**	**<100**	**101-200**	**201-300**	**301-400**	**>400**	**Total**
Layer 3 (320-640 cm dt.)	8	5	1	1	0	**15**
Layer 4 (340-700 cm dt.)	5	3	3	0	1	**12**
Layer 7 (520- 580 cm dt.)	0	0	1	0	0	**1**
Layer 8 (580-720 cm dt.)	0	1	1	0	0	**2**
Layer 9 (620-740 cm dt.)	2	0	0	1	0	**3**
Layer 10 (700-780 cm dt.)	1	0	0	0	0	**1**
Total	**16**	**9**	**6**	**2**	**1**	**34**

Table 4.5.3.3 The weight (in gram) of denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The weight of the denticulates is quite similar to that of the atypical small tools, with about half of the specimens (16 denticulates: 47%) weighing less than 100 g, while hardly 20% of the scrapers do so. The maximal weight is 500 g in the layer 4 **(Table 4.5.3.3, figure 4.5.3.6)**.

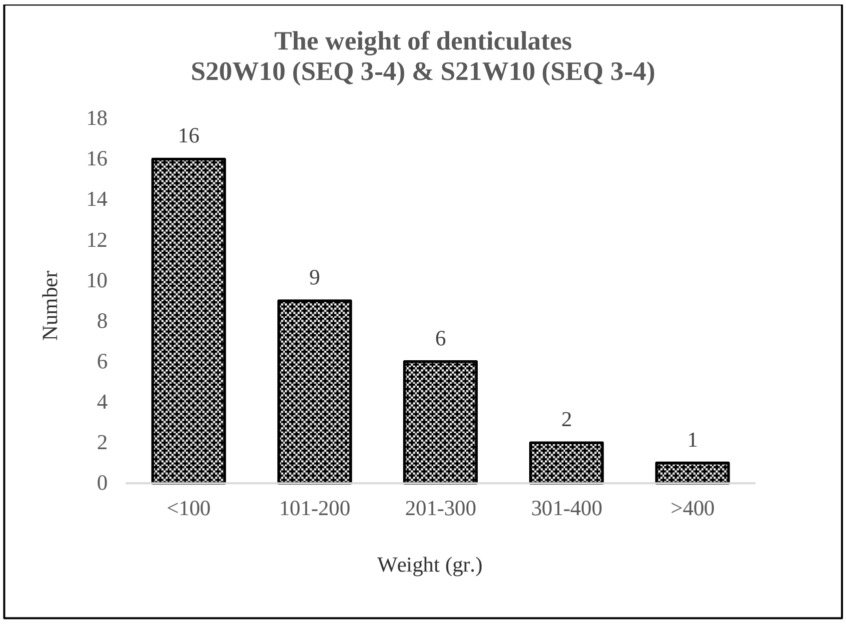


Figure 4.5.3.6 Distribution of the weight (in gram) of denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

3) Supports

Denticulates are mainly made on the broken cobbles 41% (14/34), especially in the upper layers, while in the lower layers the very few denticulates are mainly made on flakes. For the whole sequence, the flakes are representing 23% (8/34; **Table 4.5.3.4**).

Supports **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Broken Cobble**		**Cobble fragment**		**Pebble fragment**		**Flake**		**Fragment**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**5**	34	**2**		**2**		**2**		**4**		**15**
Layer 4 (340-700 cm dt.)	**7**	58	**2**		**0**		**2**		**1**		**12**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**0**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**0**		**0**		**1**		**2**		**0**		**3**
Layer 9 (620-740 cm dt.)	**1**		**0**		**0**		**1**		**0**		**2**
Layer 10 (700-780 cm dt.)	**0**		**0**		**0**		**1**		**0**		**1**
Total	**14**	41	**4**	4/34	**3**		**8**	23	**5**	15	**34**

Table 4.5.3.4 The supports of denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

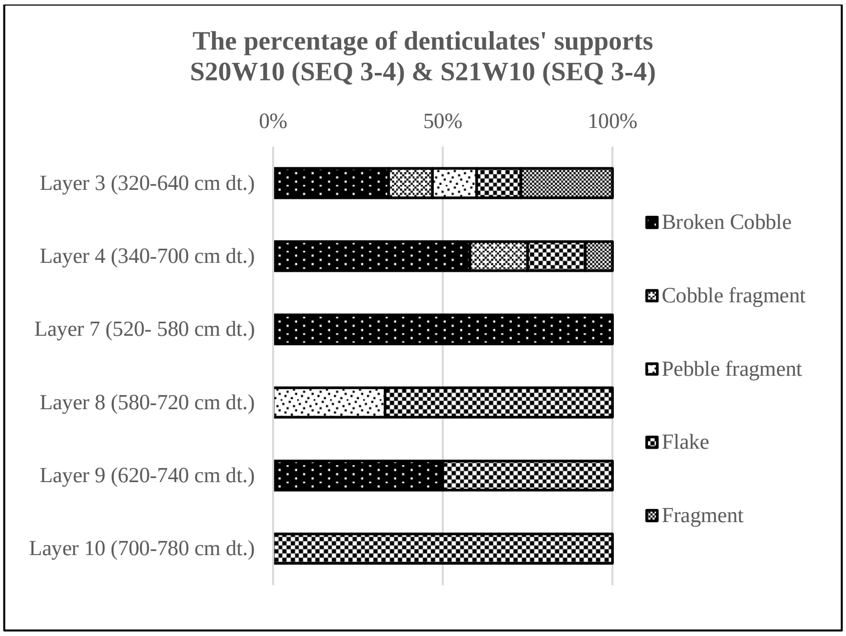


Figure 4.5.3.7 Distribution of the supports of denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4) General morphology of denticulates

Only the irregular shape is globally preponderant in frontal view, providing 35% of the denticulates (12/34), then, the trapezoidal shape is presenting 21% (8/34). The other shapes are seldom represented in the studied sectors **(Table 4.5.3.5)**.

In the transversal view, the triangular and trapezoidal shapes are the most common (38%: 13/42 and 29%: 10/34 respectively), suggesting that these tools have at least one lateral cutting edge **(Table 4.5.3.6)**.

4.1) Frontal view

Frontal view **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Irregular**		**Trapezoidal**		**Half-oval**		**Triangular**		**D-shape**		**Oval**		**Pentagonal**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**5**	33	**5**	33	**1**		**1**		**1**		**1**		**1**		**15**
Layer 4 (340-700 cm dt.)	**5**	42	**1**		**3**		**1**		**1**		**1**		**0**		**12**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**0**		**0**		**0**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**1**		**0**		**1**		**0**		**0**		**0**		**0**		**2**
Layer 9 (620-740 cm dt.)	**0**		**2**		**0**		**1**		**0**		**0**		**0**		**3**
Layer 10 (700-780 cm dt.)	**0**		**0**		**0**		**1**		**0**		**0**		**0**		**1**
Total	**12**	35	**8**	21	**5**	15	**4**	4/34	**2**		**2**		**1**		**34**

Table 4.5.3.5 The frontal view of denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4.2) Transversal view

Transversal view **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Triangular**		**Trapezoidal**		**Irregular**		**Oval**		**Pentagonal**		**D-shape**		**Half-oval**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**6**	40	**5**	33	**2**		**0**		**2**		**0**		**0**		**15**
Layer 4 (340-700 cm dt.)	**4**		**2**		**0**		**3**		**0**		**2**		**1**		**12**
Layer 7 (520- 580 cm dt.)	**0**		**1**		**0**		**0**		**0**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**1**		**0**		**1**		**0**		**0**		**0**		**0**		**2**
Layer 9 (620-740 cm dt.)	**2**		**1**		**0**		**0**		**0**		**0**		**0**		**3**
Layer 10 (700-780 cm dt.)	**0**		**1**		**0**		**0**		**0**		**0**		**0**		**1**
Total	**13**	38	**10**	29	**3**	3/34	**3**	3/34	**2**		**2**		**1**		**34**

Table 4.5.3.6 The transversal view of denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

5) Shaping of the denticulates

5.1) Amount of cortex

- On the upper face

Amount of cortex **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**7**	47	**3**		**5**	33	**15**
Layer 4 (340-700 cm dt.)	**5**	42	**4**		**3**		**12**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**1**		**1**		**0**		**2**
Layer 9 (620-740 cm dt.)	**1**		**0**		**2**		**3**
Layer 10 (700-780 cm dt.)	**1**		**0**		**0**		**1**
Total	**16**	47	**8**	24	**10**	29	**34**

Table 4.5.3.7 Amount of cortex on upper face of the denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The upper face of denticulates is quite similar to all tools, generally cortical dominant, with nearly half of the specimens (47%: 16/34). The non-cortical and non-cortical dominant upper faces are equally frequent on the other specimens **(Table 4.5.3.7)**.

- On the lower face

Amount of cortex **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Totally cortical**		**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**10**	67	**1**		**0**		**4**		**15**
Layer 4 (340-700 cm dt.)	**5**	42	**1**		**2**		**4**		**12**
Layer 7 (520- 580 cm dt.)	**0**		**0**		**0**		**1**		**1**
Layer 8 (580-720 cm dt.)	**0**		**0**		**0**		**2**		**2**
Layer 9 (620-740 cm dt.)	**1**		**1**		**0**		**1**		**3**
Layer 10 (700-780 cm dt.)	**0**		**0**		**0**		**1**		**1**
Total	**16**	47	**3**	9	**2**		**13**	38	**34**

Table 4.5.3.8 Amount of cortex on lower face of the denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

As most of the denticulates, like the other tools, are usually unifacially shaped on broken cobbles, their lower faces are mostly totally cortical (47%: 16/34). Then they are non-cortical (38% (13/34) for the flakes and fragments. The cortical-dominant and non-cortical dominant faces represent about 15% **(Table 4.5.3.8)**.

5.2) Number of removals (shaping the tools)

- On the upper face

Number of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**1**	**2**	**3**	**4**	**5**	**6**	**9**	**>10 (~12)**	Total number of denticulates	Total number of removals	Average number of removals (total number of removals / total number of tools)
Layer 3 (320-640 cm dt.)	0	4	2	3	4	1	0	1	**15**	**64**	4,3
Layer 4 (340-700 cm dt.)	0	2	0	4	1	2	1	2	**12**	**58**	4,8
Layer 7 (520- 580 cm dt.)	0	0	0	0	0	0	1	0	**1**	**9**	9,0
Layer 8 (580-720 cm dt.)	1	0	0	0	0	0	0	1	**2**	**13**	6,5
Layer 9 (620-740 cm dt.)	0	0	0	1	1	0	0	1	**3**	**21**	7,0
Layer 10 (700-780 cm dt.)	1	0	0	0	0	0	0	0	**1**	**1**	1,0
Total	**2**	**6**	**2**	**8**	**6**	**3**	**2**	**5**	**34**	**166**	4,9

Table 4.5.3.9 Number of removals on upper face of the denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The average number of removals (excluding the retouches < 5 mm) shaping the denticulates is usually of 4 to 5 in the upper layers 3 and 4. This is slightly more than for the end scrapers but similar to the side scrapers. In the lower layers the number of removals is quite variable, but the specimens are very few **(Tables 4.5.3.9)**.

- On the lower face

Number of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**3**	**4**	**5**	Total number of denticulates with removals on the lower face	Total number of removals	Average number of removals (total number of removals / total number of tools)
Layer 3 (320-640 cm dt.)	0	2	0	**2**	**8**	4,0
Layer 4 (340-700 cm dt.)	0	1	1	**2**	**9**	4,5
Layer 9 (620-740 cm dt.)	1	0	0	**1**	**3**	3,0
Total	**1**	**3**	**1**	**5**	**20**	4,0

Table 4.5.3.10 Number of removals on lower face of the denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Only 5 denticulates have removals on their lower face, the number of which is between 3 and 5 (**Table 4.5.3.10**).

5.3) Direction of removals

- On the upper face

Direction of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Unipolar**		**Bipolar-opposite**		**Bidirectional-orthogonal**		**Three-directions**		**Convergent**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**12**	80	**1**		**1**		**0**		**1**		**15**
Layer 4 (340-700 cm dt.)	**7**	58	**2**		**0**		**0**		**3**		**12**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**0**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**1**		**0**		**1**		**0**		**0**		**2**
Layer 9 (620-740 cm dt.)	**2**		**0**		**0**		**1**		**0**		**3**
Layer 10 (700-780 cm dt.)	**1**		**0**		**0**		**0**		**0**		**1**
Total	**24**	70	**3**		**2**		**1**		**4**		**34**

Table 4.5.3.11 Direction of removals on the upper face of the denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

- *On the lower face*

Direction of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Unipolar**		**Bidirectional-orthogonal**		**Convergent**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**1**		**1**		**0**		**2**
Layer 4 (340-700 cm dt.)	**0**		**1**		**1**		**2**
Layer 9 (620-740 cm dt.)	**1**		**0**		**0**		**1**
Total	**2**		**2**		**1**		**5**

Table 4.5.2.12 Direction of removals on the lower face of the denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Denticulates are mostly shaped by unipolar unidirectional removals on the upper face (24/34: 70%) indicating that only one edge is shaped. The other patterns of removals are rarely represented, except for the convergent pattern, outstanding in the layer 4 (25%) and recalling tools almost shaped all around like the sumatraliths **(Table 4.5.2.11)**.

5.4) Length of the longest removal

- *On the upper face*

Longest removal **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**7-10**	**11-20**	**21-30**	**31-40**	**41-50**	**51-60**	Total number of denticulates	Average maximal length (mm)
Layer 3 (320-640 cm dt.)	0	11	4	0	0	0	**15**	19
Layer 4 (340-700 cm dt.)	2	5	2	1	2	0	**12**	22
Layer 7 (520- 580 cm dt.)	1	0	0	0	0	0	**1**	8
Layer 8 (580-720 cm dt.)	1	1	0	0	0	0	**2**	13
Layer 9 (620-740 cm dt.)	0	2	0	0	0	1	**3**	27
Layer 10 (700-780 cm dt.)	0	1	0	0	0	0	**1**	20
Total	**4**	**20**	**6**	**1**	**2**	**1**	**34**	

Table 4.5.3.13 Length of the longest removal (in mm) on upper face of denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

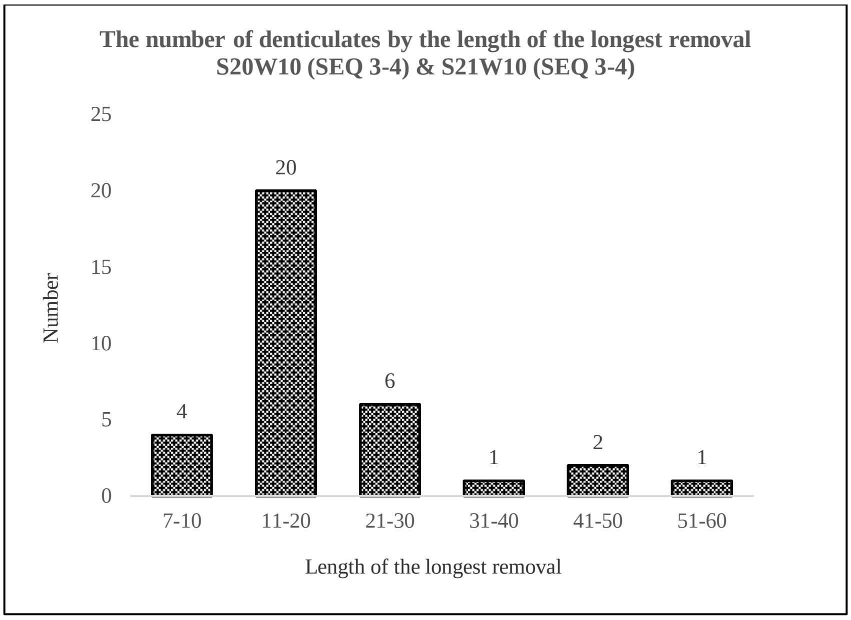


Figure 4.5.3.8 Distribution of length of the longest removal (in mm) on upper face of denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The length of the longest removal on the upper face of the denticulates varies between 7 and 60 mm, but is mostly between 11 and 20 mm (nearly 60%: 20/34). These removals are slightly smaller than on the end and side scrapers **(Table 4.5.3.13, figure 4.5.3.8)**.

- *On the lower face*

Longest length **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**10-20**	**21-30**	**31-40**	Total number of denticulates	Average maximal length
Layer 3 (320-640 cm dt.)	2	0	0	2	14
Layer 4 (340-700 cm dt.)	0	1	1	2	29
Layer 9 (620-740 cm dt.)	1	0	0	1	12
Total	**3**	**1**	**1**	**5**	

Table 4.5.3.14 Length of the longest removal on lower face of denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

On the lower face, the longest removals are mostly less than 10 mm **(Table 4.5.3.14)**.

6) Morpho-functional features of denticulates: Nature of the edges

6.1) Nature of the lateral edges

Right side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Retouch Unifacial**		**Retouch Bifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**9**	60	**2**		**0**		**0**		**15**
Layer 4 (340-700 cm dt.)	**3**		**4**		**3**		**2**		**0**		**12**
Layer 7 (520- 580 cm dt.)	**0**		**1**		**0**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**0**		**0**		**0**		**1**		**1**		**2**
Layer 9 (620-740 cm dt.)	**0**		**1**		**1**		**1**		**0**		**3**
Layer 10 (700-780 cm dt.)	**0**		**1**		**0**		**0**		**0**		**1**
Total	**7**	20	**16**	47	**6**	18	**4**		**1**		**34**

Left side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Retouch Unifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**3**		**6**	40	**4**		**2**		**15**
Layer 4 (340-700 cm dt.)	**2**		**6**	50	**2**		**2**		**12**
Layer 7 (520- 580 cm dt.)	**0**		**0**		**1**		**0**		**1**
Layer 8 (580-720 cm dt.)	**1**		**1**		**0**		**0**		**2**
Layer 9 (620-740 cm dt.)	**0**		**2**		**1**		**0**		**3**
Layer 10 (700-780 cm dt.)	**0**		**0**		**1**		**0**		**1**
Total	**6**	18	**15**	44	**9**	26	**4**		**34**

Table 4.5.3.15 Nature of the lateral (right and left) edges of the denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Both lateral edges of denticulates are rather similar in nature. About one third of them are shaped either by removals or by retouch, almost always unifacial. In almost half of the cases they are formed by a fracture; the other lateral edges are cortical (**Table 4.5.3.15**).

6.2) Nature of the distal edge

Distal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Retouch Unifacial**		**Pointed**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**3**		**3**		**3**		**1**		**3**		**2**		**15**
Layer 4 (340-700 cm dt.)	**0**		**1**		**6**	50	**0**		**3**		**2**		**12**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**0**		**0**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**0**		**0**		**0**		**0**		**2**		**0**		**2**
Layer 9 (620-740 cm dt.)	**0**		**2**		**1**		**0**		**0**		**0**		**3**
Layer 10 (700-780 cm dt.)	**0**		**1**		**0**		**0**		**0**		**0**		**1**
Total	**4**		**7**	21	**10**	29	**1**		**8**	23	**4**		**34**

Table 4.5.3.16 Nature of the distal edge of the denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Most of the denticulates are shaped or retouched on their distal edge (68%: 23/34), with possible extension on another edge. Distal fractures occur on about 20% of the specimens **(Table 4.5.3.16)**

6.3) Nature of the proximal edge

Proximal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Retouch Unifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**5**	33	**3**		**3**		**15**
Layer 4 (340-700 cm dt.)	**2**		**4**		**5**	42	**1**		**12**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**0**		**2**		**0**		**0**		**2**
Layer 9 (620-740 cm dt.)	**1**		**2**		**0**		**0**		**3**
Layer 10 (700-780 cm dt.)	**1**		**0**		**0**		**0**		**1**
Total	**9**	26	**13**	38	**8**	24	**4**		**34**

Table 4.5.3.17 Nature of the edge of proximal side of the denticulate from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The proximal edges are mostly fractures (38%: 13/34) or then they are cortical. Shaping of the proximal edge occurs for one third of the denticulates (12/34; **Table 4.5.3.17**).

7) Morpho-functional features of denticulates: Angle of the edges

7.1) Angle of right and left edges

Right side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**6**	40	**4**		**4**		**1**		**15**
Layer 4 (340-700 cm dt.)	**4**		**5**	42	**2**		**1**		**12**
Layer 7 (520- 580 cm dt.)	**0**		**1**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**1**		**1**		**0**		**0**		**2**
Layer 9 (620-740 cm dt.)	**2**		**0**		**1**		**0**		**3**
Layer 10 (700-780 cm dt.)	**0**		**1**		**0**		**0**		**1**
Total	**13**	38	**12**	35	**7**	21	**2**		**34**

Left side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**6**	40	**5**	33	**0**		**15**
Layer 4 (340-700 cm dt.)	**2**		**5**	42	**4**		**1**		**12**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**1**		**1**		**0**		**0**		**2**
Layer 9 (620-740 cm dt.)	**0**		**0**		**1**		**2**		**3**
Layer 10 (700-780 cm dt.)	**0**		**1**		**0**		**0**		**1**
Total	**8**	24	**13**	38	**10**	29	**3**		**34**

Table 4.5.3.18 Angle of right and left edges of the denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The angle of right and left edges of the denticulates appear slightly different: they are more often acute on the right side and steep or steep inverse on the left side. Oblique (medium angled) edges are equally frequent on both sides. It should be reminded that some removals on the lateral sides can extend on the distal or proximal edges **(Table 4.5.3.18)**.

7.2) Angle of distal edge

Distal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Very-acute**		**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**2**		**7**	47	**3**		**2**		**1**		**15**
Layer 4 (340-700 cm dt.)	**1**		**5**	42	**1**		**4**		**1**		**12**
Layer 7 (520- 580 cm dt.)	**0**		**1**		**0**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**0**		**1**		**1**		**0**		**0**		**2**
Layer 9 (620-740 cm dt.)	**0**		**0**		**1**		**2**		**0**		**3**
Layer 10 (700-780 cm dt.)	**0**		**0**		**0**		**1**		**0**		**1**
Total	**3**		**14**	41	**6**	18	**9**	26	**2**		**34**

Table 4.5.3.19 Angle of distal edge of the denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The distal edge of denticulates is more frequently acute (sharp angled; 41%: 14/34) and even very acute, as it is more often shaped or retouched. The oblique edges are rather few and the steep or steep-inverse (open angled) represent on third of the cases (11/34; **Table 4.5.3.19)**.

7.3) Angle of proximal edge

Distal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**1**		**8**	53	**4**		**2**		**15**
Layer 4 (340-700 cm dt.)	**3**		**2**		**3**		**4**		**12**
Layer 7 (520- 580 cm dt.)	**0**		**0**		**0**		**1**		**1**
Layer 8 (580-720 cm dt.)	**0**		**0**		**2**		**0**		**2**
Layer 9 (620-740 cm dt.)	**0**		**2**		**0**		**1**		**3**
Layer 10 (700-780 cm dt.)	**0**		**1**		**0**		**0**		**1**
Total	**4**		**13**	38	**9**	26	**8**	24	**34**

Table 4.5.3.20 Angle of proximal edge of the denticulates from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

By contrast, the proximal edges are mostly steep or steep-inverse (around 50%: 17/34) or oblique (medium angled; 38%, 13/34), as they are usually made up of a fracture or of original cortex of the cobble **(Tables 4.5.3.20)**.

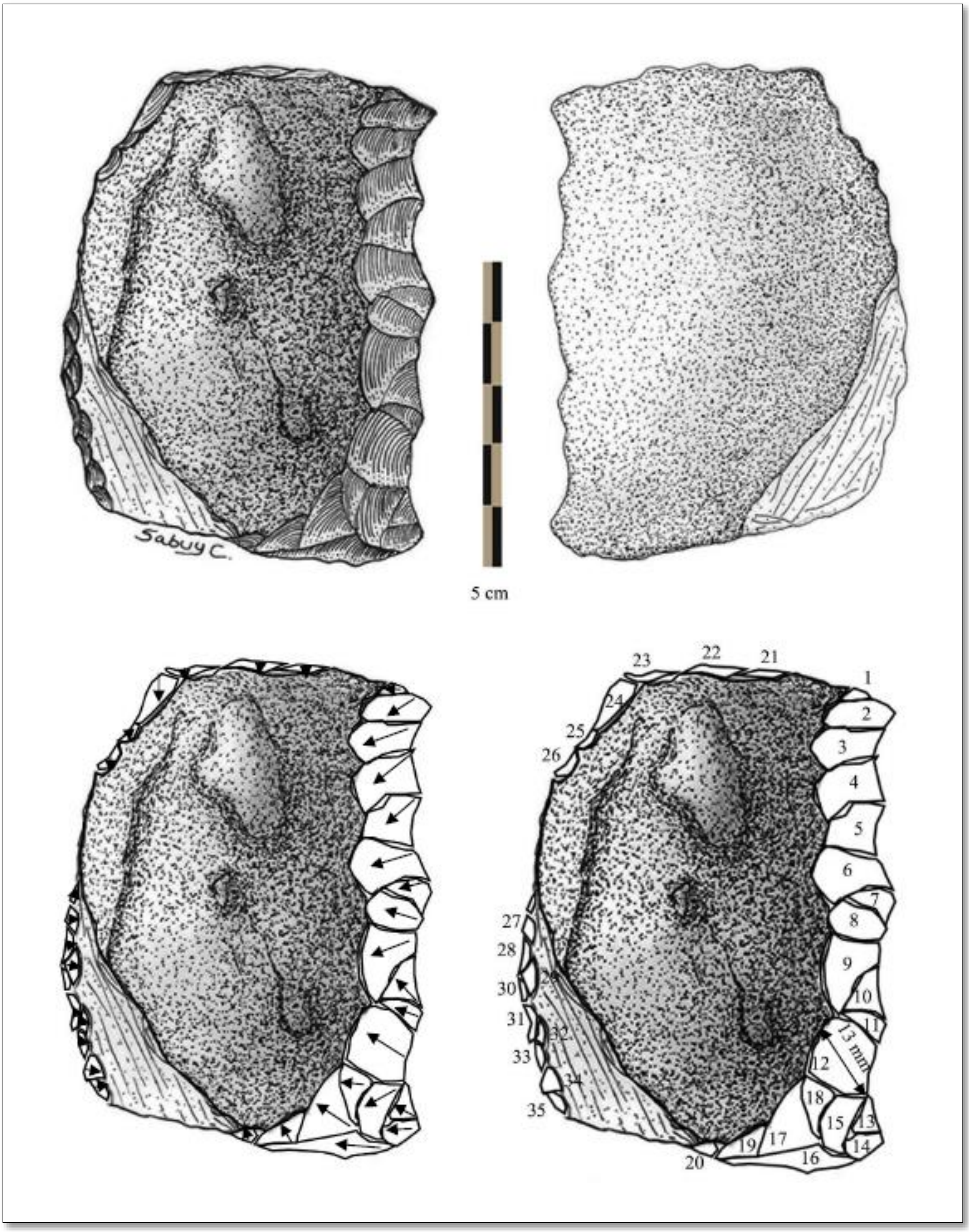


Figure 4.5.3.9 Main form of denticulate found at Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4); illustrating the direction and number of removals and retouches (< 5 mm; drawings T. Chitkament)

4.5.4 Pointed tools

1) General features of the pointed tools

Around 6% (23/411) of the small tools in the stratigraphic layers 3 to 10 of area 2, sectors S20W10 & S21W10, are pointed tools. They are not representative in the proportions, but preponderant in the upper layer 4 (11/121= 9%). They may be suspected of having a good representation in the lower layer 10 (2/7), but the total amount of small tools in this layer is too little for having a statistical significance (**Table 4.5.4.1)**.

Pointed tools	**Layer 3**		**Layer 4**		**Layer 5**		**Layer 6**		**Layer 7**		**Layer 8**		**Layer 9**		**Layer 10**		**Total**
Numbers (%)	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
S20W10 (SEQ 3-4)	**5**	4	**8**	7							**1**		**0**		**2**		**16**
S21W10 (SEQ 3-4)	**0**		**3**		**0**		**1**		**1**		**0**		**2**		**0**		**7**
S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**5**	4	**11**	9	**0**		**1**		**1**		**1**		**2**		**2**		**23** (6%)
Small tools S20W10 (SEQ3-4) & S21W10 (SEQ 3-4)	**128**		**121**		**14**		**31**		**28**		**43**		**39**		**7**		**411**

Table 4.5.4.1 Total number of pointed tools in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Raw materials **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Gray sandstone**		**Black sandstone**		**Siliceous shale**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**1**		**0**		**5**
Layer 4 (340-700 cm dt.)	**10**	91	**0**		**1**		**11**
Layer 6 (470- 520 cm dt.)	**0**		**1**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**0**		**1**		**0**		**1**
Layer 9 (620-740 cm dt.)	**2**		**0**		**0**		**2**
Layer 10 (700-780 cm dt.)	**1**		**1**		**0**		**2**
Total	**18**	78	**4**		**1**		**23**

Table 4.5.4.2 The raw materials of pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The large majority (18/23=78%) of the pointed tools are made in gray sandstone, like all the artefacts from Tham Lod Rockshelter **(Table 4.5.4.2)**.

2) Measurements

Measurement **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Length (mm)**	**Width (mm)**	**Thickness (mm)**	**Number of pointed tools**
Layer 3 (320-640 cm dt.)	80	46	28	5
Layer 4 (340-700 cm dt.)	70	47	32	11
Layer 6 (470- 520 cm dt.)	86	31	25	1
Layer 7 (520- 580 cm dt.)	98	53	41	1
Layer 8 (580-720 cm dt.)	85	68	27	1
Layer 9 (620-740 cm dt.)	79	48	29	2
Layer 10 (700-780 cm dt.)	81	61	38	2
Average	**76**	**48**	**31**	**23**

Table 4.5.4.3 Average dimensions of the pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The average measurements of the pointed tools (76, 48 and 31 mm for length, width and thickness respectively) are quite similar to those of the denticulates and atypical small tools; compared to the scrapers they have about the same length but they are narrower and thinner. The longest pointed tool, and also the thickest is in the layer 7 (98 mm), and the shortest is in the layer 4 (48 mm), while the widest is in the layer 8 (68 mm) and the narrowest is in the layer 6 (31 mm; **Table 4.5.4.3, figures 4.5.4.4 & 4.5.4.5)**.

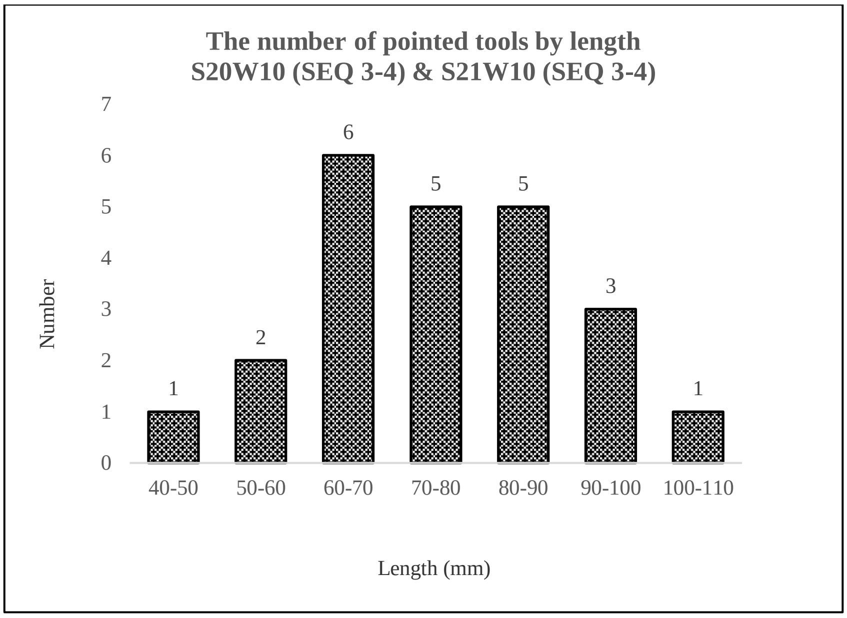


Figure 4.5.4.1 Distribution of the length of the pointed tools from Tham Lod Rockshelter area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

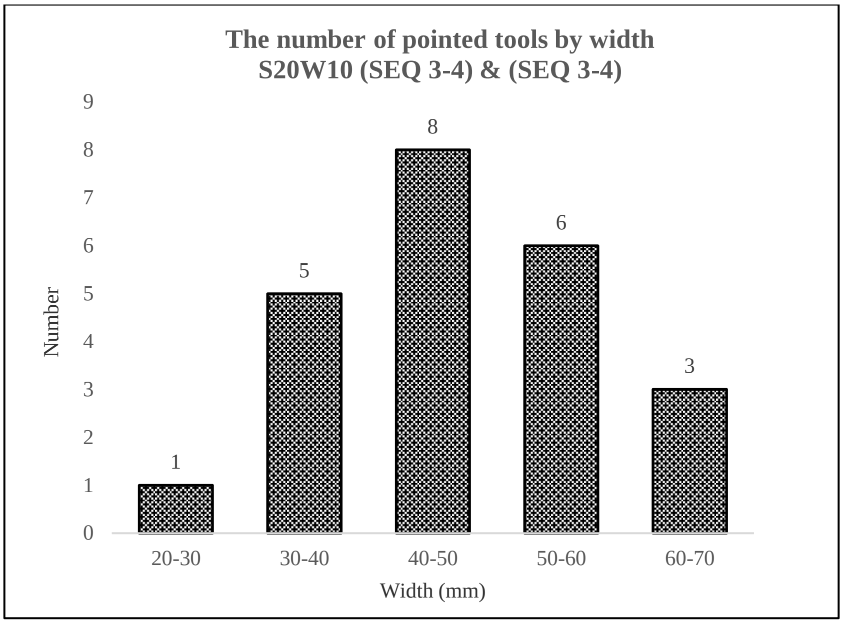


Figure 4.5.4.2 Distribution of the width of the pointed tools from Tham Lod Rockshelter area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

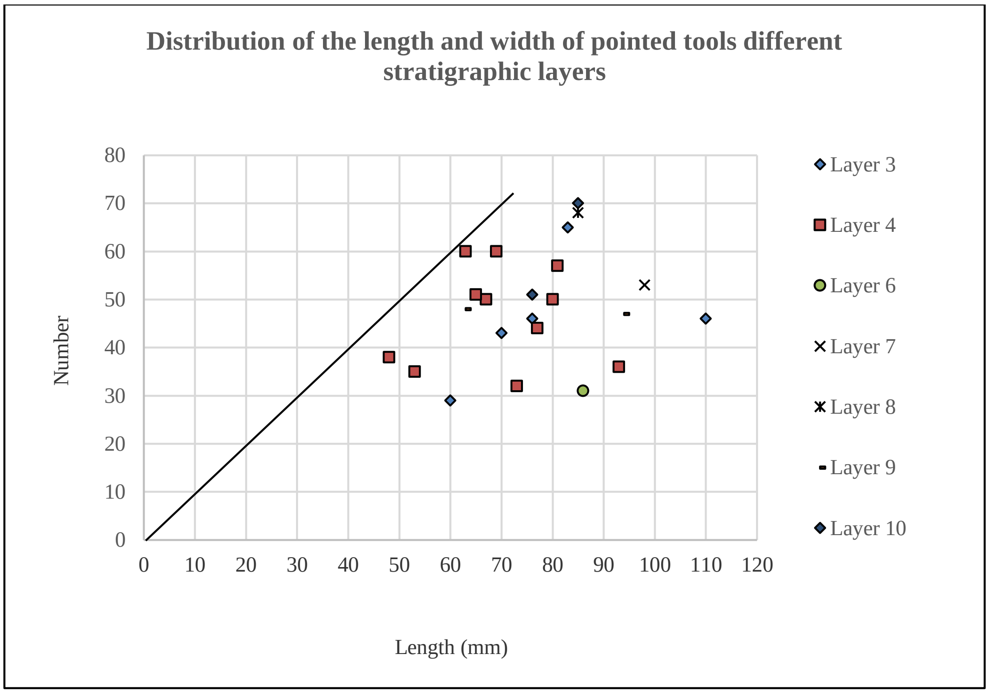


Figure 4.5.4.3 Scatter diagram length x width of the pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

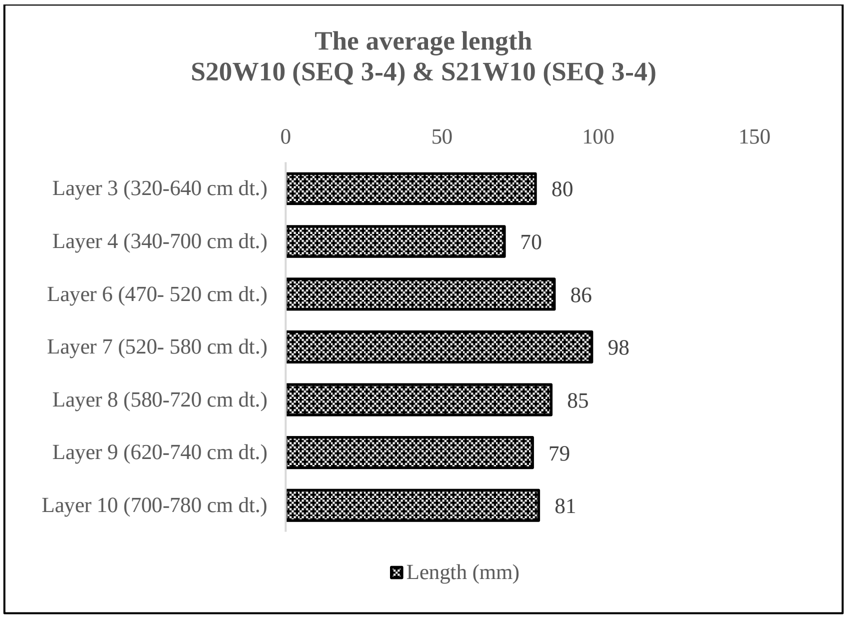


Figure 4.5.4.4 Distribution of the average length of the pointed tools across the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

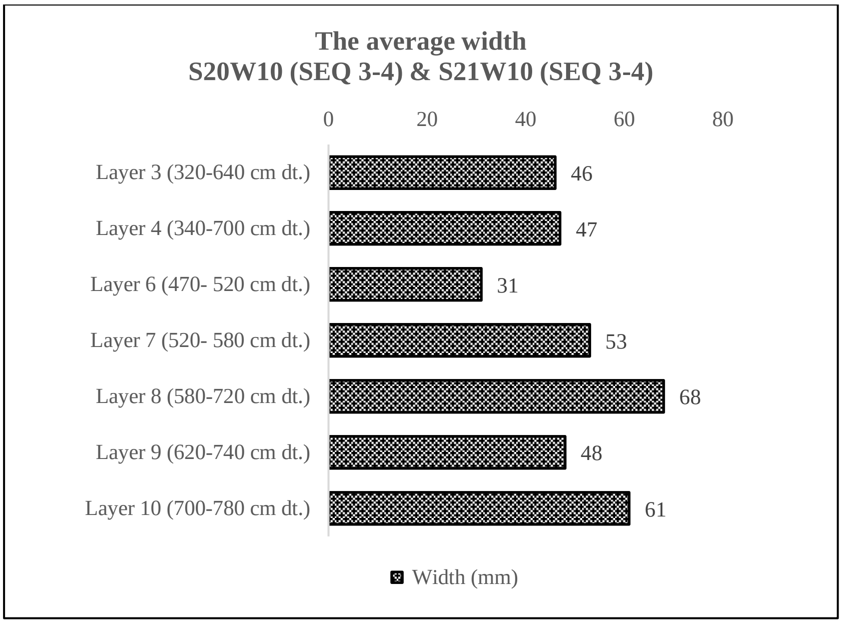


Figure 4.5.4.5 Distribution of the average width of the pointed tools across the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Weight (gr.) **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**<100**	**101-200**	**201-300**	**301-400**	**Total**
Layer 3 (320-640 cm dt.)	1	4	0	0	**5**
Layer 4 (340-700 cm dt.)	4	5	2	0	**11**
Layer 6 (470- 520 cm dt.)	1	0	0	0	**1**
Layer 7 (520- 580 cm dt.)	0	0	0	1	**1**
Layer 8 (580-720 cm dt.)	0	0	1	0	**1**
Layer 9 (620-740 cm dt.)	0	1	1	0	**2**
Layer 10 (700-780 cm dt.)	0	1	1	0	**2**
Total	**6**	**11**	**5**	**1**	**23**

Table 4.5.4.4 The weight (in gram) of pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

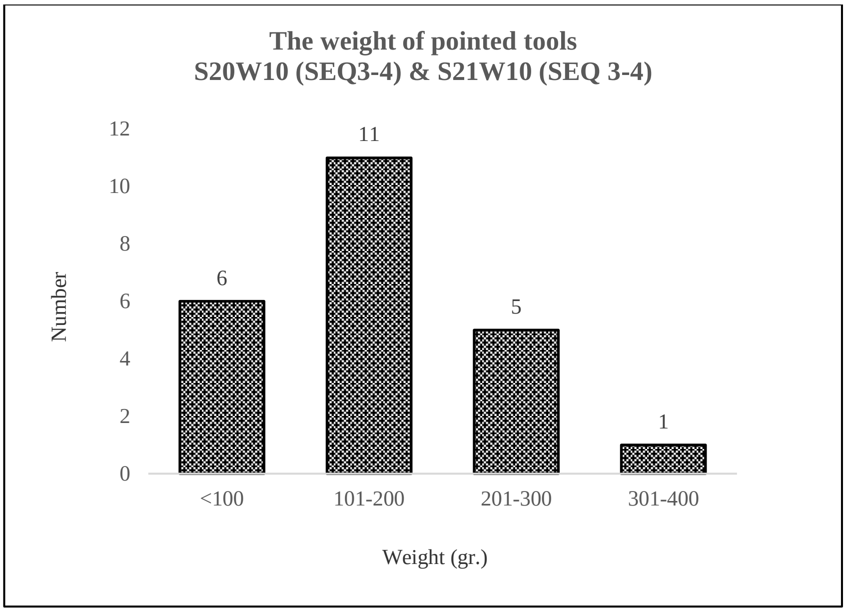


Figure 4.5.4.6 Distribution of the weight (in gram) of pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The pointed tools mostly weigh between 100 and 200 g (11 tools: 48%). They are heavier than the denticulates and atypical small tools, but slightly lighter than the scrapers **(Table 4.5.4.4, figure 4.5.4.6)**.

3) Supports

The main supports of pointed tools are the broken cobbles (35%: 8/23), cobble fragments (26%: 6/23) or broken pebbles (22%: 5/23). The other supports like pebble fragments, flakes and fragments are infrequent, less than 10% of the pointed tools **(Table 4.5.4.5, figure 4.5.4.7)**.

Supports **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Broken Cobble**		**Cobble fragment**		**Broken pebble**		**Pebble fragment**		**Flake**		**Fragment**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**2**		**2**		**1**		**0**		**0**		**0**		**5**
Layer 4 (340-700 cm dt.)	**3**		**4**		**1**		**1**		**1**		**1**		**11**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**0**		**0**		**0**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**0**		**0**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**0**		**0**		**0**		**0**		**1**		**0**		**1**
Layer 9 (620-740 cm dt.)	**1**		**0**		**1**		**0**		**0**		**0**		**2**
Layer 10 (700-780 cm dt.)	**0**		**0**		**2**		**0**		**0**		**0**		**2**
Total	**8**	35	**6**	26	**5**	22	**1**		**2**		**1**		**23**

Table 4.5.4.5 The supports of pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

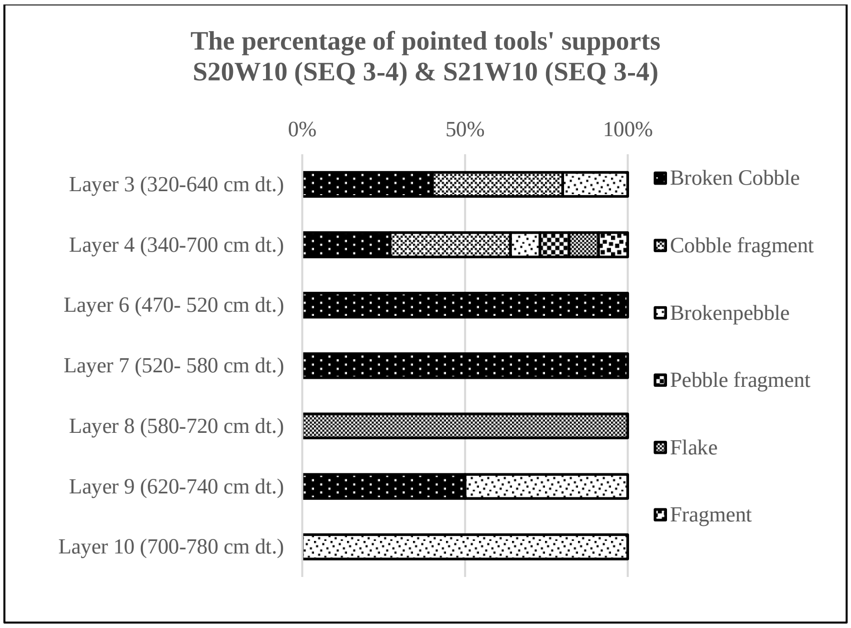


Figure 4.5.4.7 Distribution of the supports of pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4) General morphology of pointed tools

4.1) Frontal view

Frontal view **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Trapezoidal**		**Irregular**		**Triangular**		**Almond**		**Pentagonal**		**Bi-convex**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**2**		**1**		**2**		**0**		**0**		**0**		**5**
Layer 4 (340-700 cm dt.)	**2**		**3**		**2**		**3**		**1**		**0**		**11**
Layer 6 (470- 520 cm dt.)	**0**		**1**		**0**		**0**		**0**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**0**		**0**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**1**		**0**		**0**		**0**		**0**		**0**		**1**
Layer 9 (620-740 cm dt.)	**1**		**1**		**0**		**0**		**0**		**0**		**2**
Layer 10 (700-780 cm dt.)	**0**		**0**		**1**		**0**		**0**		**1**		**2**
Total	**7**	31	**6**	26	**5**	22	**3**	3/23	**1**		**0**		**23**

Table 4.5.4.6 The frontal view of pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4.2) Transversal view

Transversal view **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Trapezoidal**		**Triangular**		**Half-oval**		**Pentagonal**		**Irregular**		**D-shape**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**2**		**3**		**0**		**0**		**0**		**0**		**5**
Layer 4 (340-700 cm dt.)	**1**		**2**		**4**		**3**		**0**		**1**		**11**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**0**		**0**		**0**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**0**		**0**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**1**		**0**		**0**		**0**		**0**		**0**		**1**
Layer 9 (620-740 cm dt.)	**1**		**0**		**0**		**0**		**1**		**0**		**2**
Layer 10 (700-780 cm dt.)	**2**		**0**		**0**		**0**		**0**		**0**		**2**
Total	**9**	39	**5**	22	**4**	4/23	**3**	3/23	**1**		**1**		**23**

Table 4.5.4.7 The transversal view of pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The pointed tools display various shapes in frontal view, mostly trapezoidal (31%: 7/23), irregular (26%: 6/23), or triangular (22%: 5/23), all these shapes having an angle turned into a point by shaping of one side at least (**Table 4.5.4.6)**.

In the transversal view, the trapezoidal shape is the most common in all the layers (nearly 40%: 9/23), then the triangular and half-oval shapes (5/23 and 4/23), occur in the upper layers 3 and 4 **(Table 4.5.4.7)**.

5) Shaping of the pointed tools

5.1) Amount of cortex

- *On the upper face*

Amount of cortex **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**0**		**1**		**5**
Layer 4 (340-700 cm dt.)	**5**	46	**5**	45	**1**		**11**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**0**		**1**		**0**		**1**
Layer 9 (620-740 cm dt.)	**1**		**1**		**0**		**2**
Layer 10 (700-780 cm dt.)	**0**		**1**		**1**		**2**
Total	**12**	52	**8**	35	**3**		**23**

Table 4.5.4.8 Amount of cortex on upper face of the pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

- *On the lower face*

Amount of cortex **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Totally cortical**		**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**1**		**1**		**1**		**2**		**5**
Layer 4 (340-700 cm dt.)	**4**		**2**		**1**		**4**		**11**
Layer 6 (470- 520 cm dt.)	**0**		**0**		**0**		**1**		**1**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**0**		**0**		**0**		**1**		**1**
Layer 9 (620-740 cm dt.)	**1**		**1**		**0**		**0**		**2**
Layer 10 (700-780 cm dt.)	**0**		**1**		**0**		**1**		**2**
Total	**7**	30	**5**	22	**2**		**9**	39	**23**

Table 4.5.4.9 Amount of cortex on lower face of the pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The upper face of the pointed tools is mostly "cortical dominant" (52%: 12/35) and then non-cortical dominant, while it is rarely non-cortical. Of course it is never totally cortical since it is shaped **(Table 4.5.4.8)**.

The lower face of pointed tools is often devoid of cortex (non-cortical, 39%: 9/23); this feature corresponds to the tools made on cobble fragments, flakes and fragments. The other faces are "cortical-dominant" and "totally cortical", but the ones with just a little cortex (non-cortical dominant) are rare **(Table 4.5.4.9)**.

5.2) Number of removals (shaping the tools)

- On the upper face

Number of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**1**	**2**	**3**	**4**	**5**	Total number of pointed tools	Total number of removals	Average number of removals (total number of removals / total number of tools)
Layer 3 (320-640 cm dt.)	1	1	1	1	1	**5**	**15**	3,0
Layer 4 (340-700 cm dt.)	4	4	2	0	1	**11**	**23**	2,1
Layer 6 (470- 520 cm dt.)	0	1	0	0	0	**1**	**2**	2,0
Layer 7 (520- 580 cm dt.)	0	0	1	0	0	**1**	**3**	3,1
Layer 8 (580-720 cm dt.)	0	1	0	0	0	**1**	**2**	2,1
Layer 9 (620-740 cm dt.)	1	0	1	0	0	**2**	**4**	2,0
Layer 10 (700-780 cm dt.)	0	0	0	0	2	**2**	**10**	5,0
Total	**6**	**7**	**5**	**1**	**4**	**23**	**59**	2,6

Table 4.5.4.10 Number of removals on upper face of the pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

- On the lower face

Number of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**1**	Total number of pointed tools with the removals on the lower face	Total number of removals	Average number of removals (total number of removals / total number of tools)
Layer 3 (320-640 cm dt.)	1	**1**	**1**	1
Layer 9 (620-740 cm dt.)	1	**1**	**1**	1
Total	**2**	**2**	**2**	1

Table 4.5.4.11 Number of removals on lower face of the pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The pointed tools are mostly shaped by 1 to 3 removals, excluding the retouch, on the upper face; for the lower face (two specimens) only 1 removal is observed **(Table 4.5.4.10)**.

5.3) Direction of removals

- On the upper face

Direction of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Unipolar**		**Bipolar-opposite**		**Bidirectional-orthogonal**		**Three-directions**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**5**	100	**0**		**0**		**0**		**5**
Layer 4 (340-700 cm dt.)	**8**	73	**2**		**0**		**1**		**11**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**0**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**0**		**0**		**1**		**0**		**1**
Layer 8 (580-720 cm dt.)	**0**		**0**		**1**		**0**		**1**
Layer 9 (620-740 cm dt.)	**2**		**0**		**0**		**0**		**2**
Layer 10 (700-780 cm dt.)	**1**		**0**		**0**		**1**		**2**
Total	**17**	74	**2**		**2**		**2**		**23**

Table 4.5.4.12 Direction of removals on upper face of the pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

- *On the lower face*

Direction of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Unipolar**		**Total**
Stratigraphic layers	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**1**		**1**
Layer 9 (620-740 cm dt.)	**1**		**1**
Total	**2**		**2**

Table 4.5.4.13 Direction of removals on lower face of the pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The removals shaping the pointed tools are generally unipolar unidirectional (75%: 17/23) as they are found on one edge which forms an acute angle, *i.e.* a point, with an adjacent edge only retouched. In a few cases, two adjacent edges are shaped, providing other patterns like “bidirectional-orthogonal”, “bipolar-opposite” and “three-directions” **(Table 4.5.4.12)**.

5.4) Length of the longest removal

- *On the upper face*

Longest removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**10-20**	**21-30**	**31-40**	**41-50**	**51-60**	**> 60**	Total number of pointed tools	Average maximal length (mm)
Layer 3 (320-640 cm dt.)	2	2	1	0	0	0	**5**	23
Layer 4 (340-700 cm dt.)	1	6	3	1	0	0	**11**	30
Layer 6 (470- 520 cm dt.)	1	0	0	0	0	0	**1**	10
Layer 7 (520- 580 cm dt.)	0	0	0	0	0	1	**1**	62
Layer 8 (580-720 cm dt.)	1	0	0	0	0	0	**1**	20
Layer 9 (620-740 cm dt.)	0	2	0	0	0	0	**2**	23
Layer 10 (700-780 cm dt.)	1	0	0	0	1	0	**2**	39
Total	**6**	**10**	**4**	**1**	**1**	**1**	**23**	

Table 4.5.4.14 Length of the longest removal (in mm) on upper face of pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

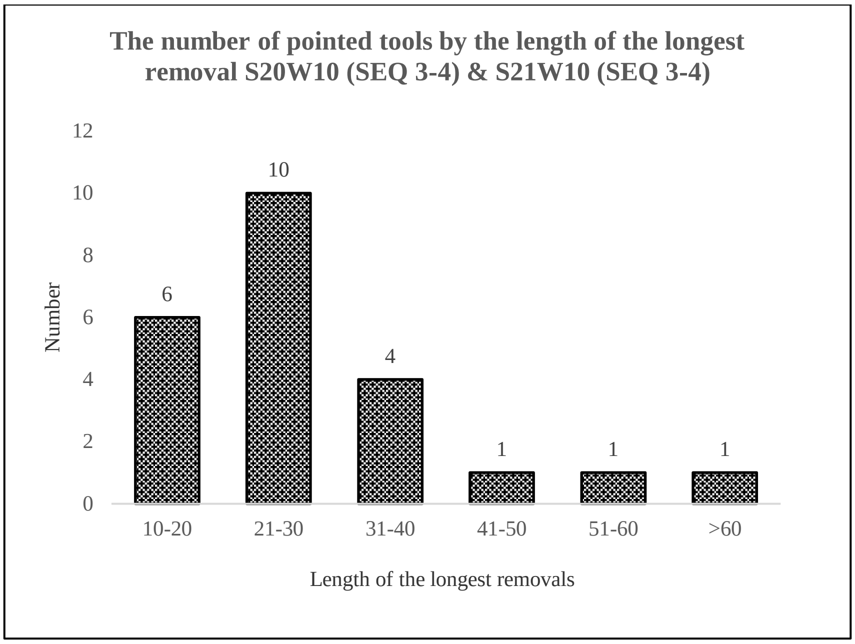


Figure 4.5.4.8 Distribution of length of the longest removal (in mm) on upper face of pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

- *On the lower face*

Longest lengths **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**20-30**	Total number of pointed tools	Average maximal length (mm)
Layer 3 (320-640 cm dt.)	1	**1**	22
Layer 9 (620-740 cm dt.)	1	**1**	28
Total	**2**	**2**	

Table 4.5.4.15 Length of the longest removal on lower face of pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The length of the longest removal on the upper face varies between 10 and 62 mm, but it concentrates between 21 and 30 mm, and nearly 45% of the artefacts are found in this range of values **(Table 4.5.4.14, figure 4.5.4.8)**.

6) Morpho-functional features of pointed tools: Nature of the edges

6.1) Nature of the lateral edges

Right side **S20W10 (SEQ 3-4) &** **S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**1**		**2**		**2**		**5**
Layer 4 (340-700 cm dt.)	**2**		**7**	64	**2**		**11**
Layer 6 (470- 520 cm dt.)	**0**		**1**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**0**		**1**		**0**		**1**
Layer 9 (620-740 cm dt.)	**0**		**1**		**1**		**2**
Layer 10 (700-780 cm dt.)	**0**		**1**		**1**		**2**
Total	**4**		**13**	57	**6**	26	**23**

Left side **S20W10 (SEQ 3-4) &** **S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**3**		**2**		**0**		**0**		**5**
Layer 4 (340-700 cm dt.)	**2**		**6**	55	**3**		**0**		**11**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**0**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**0**		**1**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**0**		**0**		**0**		**1**		**1**
Layer 9 (620-740 cm dt.)	**1**		**0**		**1**		**0**		**2**
Layer 10 (700-780 cm dt.)	**1**		**0**		**1**		**0**		**2**
Total	**8**	35	**9**	39	**5**	22	**1**		**23**

Table 4.5.4.16 Nature of the lateral (right and left) edges of the pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The pointed tools seem to be more fractured on the lateral edges (nearly 50% in the total), then the cortex is well represented on the left edge (35%: 8/23) only. Shaping occurs on about 25% of each of the lateral edges (**Table 4.5.4.16**).

6.2) Nature of the distal edge

The distal edge of the pointed tools is unifacially shaped in most of the cases (78%: 18/23); in a few cases the point is made by retouch only (22%: 5/23) **(Table 4.5.4.17)**.

Distal side S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Removal Unifacial**		**Retouched Point**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**0**		**5**	100	**5**
Layer 4 (340-700 cm dt.)	**2**		**9**	82	**11**
Layer 6 (470- 520 cm dt.)	**0**		**1**		**1**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**1**
Layer 8 (580-720 cm dt.)	**0**		**1**		**1**
Layer 9 (620-740 cm dt.)	**2**		**0**		**2**
Layer 10 (700-780 cm dt.)	**0**		**2**		**2**
Total	**5**	22	**18**	78	**23**

Table 4.5.4.17 Nature of the distal edge of the pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

6.3) Nature of the proximal edge

Proximal side S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**0**		**3**		**1**		**1**		**5**
Layer 4 (340-700 cm dt.)	**5**	46	**4**		**2**		**0**		**11**
Layer 6 (470- 520 cm dt.)	**0**		**0**		**1**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**0**		**0**		**1**
Layer 8 (580-720 cm dt.)	**1**		**0**		**0**		**0**		**1**
Layer 9 (620-740 cm dt.)	**1**		**1**		**0**		**0**		**2**
Layer 10 (700-780 cm dt.)	**1**		**0**		**1**		**0**		**2**
Total	**9**	39	**8**	35	**5**	22	**1**		**23**

Table 4.5.3.18 Nature of the proximal edge of the pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The proximal edge is mostly cortical or in the form of a fracture (nearly 75% in the whole sequence), or it is shaped, almost always unifacially, in one fourth of the cases (26%: 6/23; **Table 4.4.4.18**).

7) Morpho-functional features of pointed tools: Angle of the edges

7.1) Angle of right and left edges

Right side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**3**		**1**		**1**		**0**		**5**
Layer 4 (340-700 cm dt.)	**2**		**2**		**7**	64	**0**		**11**
Layer 6 (470- 520 cm dt.)	**0**		**0**		**1**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**0**		**0**		**1**		**0**		**1**
Layer 8 (580-720 cm dt.)	**0**		**0**		**0**		**1**		**1**
Layer 9 (620-740 cm dt.)	**0**		**0**		**0**		**2**		**2**
Layer 10 (700-780 cm dt.)	**0**		**1**		**1**		**0**		**2**
Total	**5**	22	**4**		**11**	48	**3**		**23**

Left side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**0**		**4**		**1**		**0**		**5**
Layer 4 (340-700 cm dt.)	**0**		**2**		**9**	82	**0**		**11**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**0**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**0**		**0**		**1**		**0**		**1**
Layer 8 (580-720 cm dt.)	**0**		**1**		**0**		**0**		**1**
Layer 9 (620-740 cm dt.)	**1**		**0**		**0**		**1**		**2**
Layer 10 (700-780 cm dt.)	**0**		**1**		**1**		**0**		**2**
Total	**2**		**8**	35	**12**	52	**1**		**23**

Table 4.5.4.19 Angle of right and left edge of the pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The left and right edges of the pointed tools are steep half of the cases (open angled; 50% in each side). In the other cases they are rather oblique (medium-angled) on the left side (35%; 8/23) and rather acute (sharp-angled) on the right side (22%; 5/23; **Table 4.5.4.19)**.

7.2) Angle of distal edge

The distal edge of the pointed tools is quite sharp (acute angled; nearly 75%: 17/23), followed by the oblique (medium angled; 26%: 6/23). The distal edge definitely appears as the active part of this type of tool (**Table 4.5.4.20**).

Distal side **S20W10 (SEQ 3-4) &** **S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**1**		**5**
Layer 4 (340-700 cm dt.)	**8**	73	**3**		**11**
Layer 6 (470- 520 cm dt.)	**1**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**0**		**1**		**1**
Layer 8 (580-720 cm dt.)	**1**		**0**		**1**
Layer 9 (620-740 cm dt.)	**2**		**0**		**2**
Layer 10 (700-780 cm dt.)	**1**		**1**		**2**
Total	**17**	74	**6**	26	**23**

Table 4.5.4.20 Angle of distal edge of the pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

7.3) Angle of proximal edge

Proximal side **S20W10 (SEQ 3-4) &** **S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**3**		**2**		**0**		**0**		**5**
Layer 4 (340-700 cm dt.)	**0**		**6**	55	**4**		**1**		**11**
Layer 6 (470- 520 cm dt.)	**0**		**1**		**0**		**0**		**1**
Layer 7 (520- 580 cm dt.)	**0**		**0**		**0**		**1**		**1**
Layer 8 (580-720 cm dt.)	**0**		**0**		**1**		**0**		**1**
Layer 9 (620-740 cm dt.)	**0**		**0**		**2**		**0**		**2**
Layer 10 (700-780 cm dt.)	**0**		**0**		**1**		**1**		**2**
Total	**3**		**9**	39	**8**	35	**3**		**23**

Table 4.5.4.21 Angle of proximal edge of the pointed tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The proximal edge is steep or steep-inverse for nearly half of the pointed tools (48%: 11/23), otherwise it is medium angled (39%: 9/23). Acute angles are quite rare in proximal positionin **(Table 4.5.4.21)**.

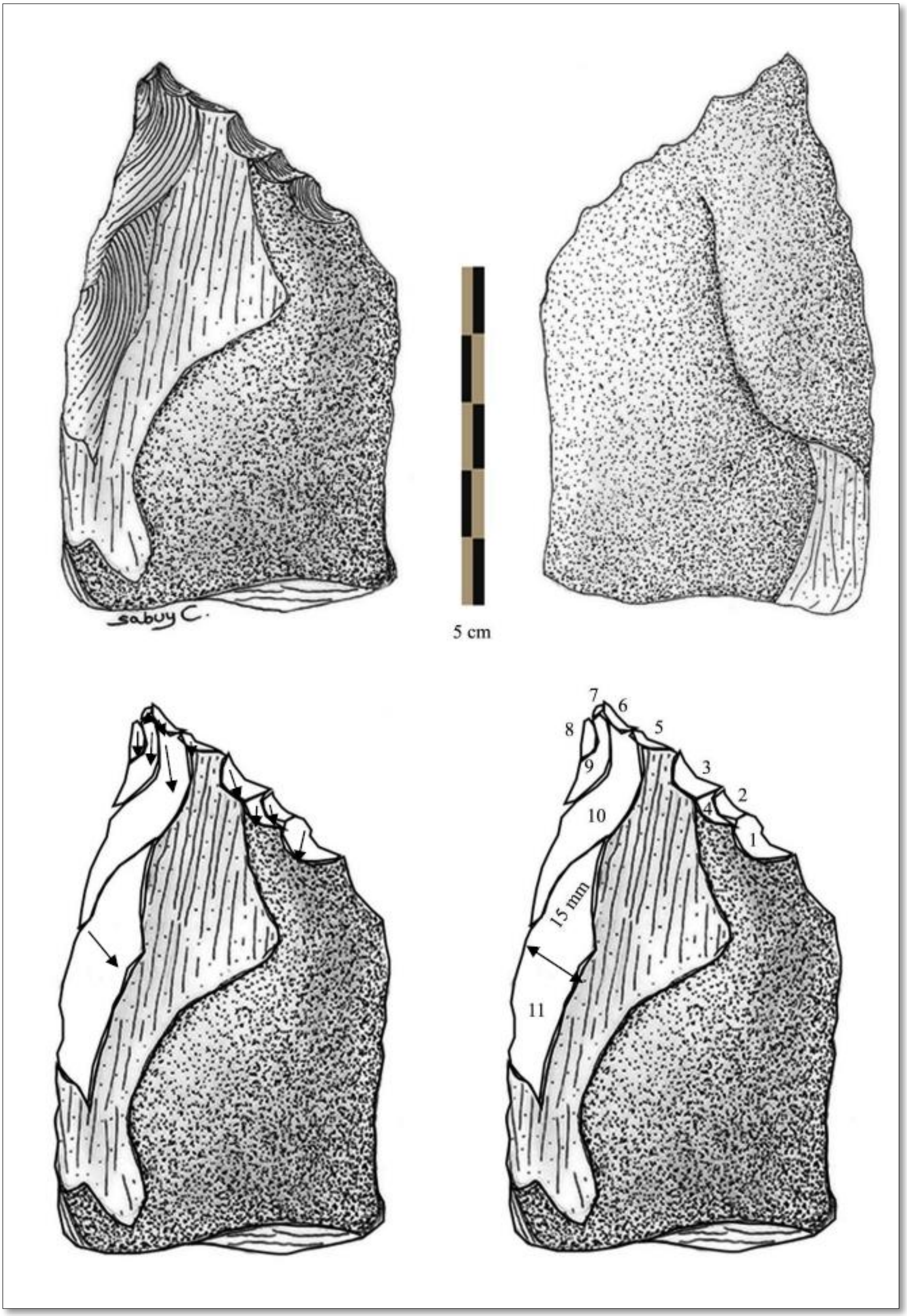


Table 4.5.4.9 Main form of pointed tool found at Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4); with illustration of the direction and number of removals and retouches (<5 mm; drawings T. Chitkament)

4.5.5 Atypical small tools

1) General features of the Atypical small tools

A total of 47 atypical small tools (11% of the small tools: 47/411) are analyzed from stratigraphic layers 3 to 10 of area 2 sectors S20W10 and S21W10. These implements are generally not relevant about typological classification. They are rather few in the layers, except, of course, in the richest upper layers 3 and 4, but in proportion they are more represented in the layer 8 (23%: 10/43; **Table 4.5.5.1)**.

Atypical small tools	**Layer 2**		**Layer 3**		**Layer 4**		**Layer 5**		**Layer 6**		**Layer 7**		**Layer 8**		**Layer 9**		**Layer 10**		**Total**
Numbers (%)	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
S20W10 (SEQ 3-4)	**2**		**9**	8	**11**	11	**0**		**0**		**0**		**8**	36	**2**		**0**		**32**
S21W10 (SEQ 3-4)	**2**		**4**		**2**		**2**		**3**		**2**		**2**		**2**		**0**		**19**
S21W10 (SEQ 1-2)	**-**		**-**		**-**		**1**		**8**	15	**3**		**-**		**-**		**-**		**12**
S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**4**		**13**	10	**13**	11	**2**		**3**		**2**		**10**	23	**4**		**0**		**47**(11%)
Small tools S20W10 (SEQ3-4) & S21W10 (SEQ 3-4)	**41**		**128**		**121**		**14**		**31**		**28**		**43**		**39**		**7**		**411**

Table 4.5.5.1 Total number of atypical small tools in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4), S21W10 (SEQ 3-4) and S21W10 (SEQ 1-2)

Raw materials **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Gray sandstone**		**Black sandstone**		**Siliceous shale**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**12**	92	**1**		**0**		**13**
Layer 4 (340-700 cm dt.)	**12**	92	**0**		**1**		**13**
Layer 5 (400-470 cm dt.)	**2**		**0**		**0**		**2**
Layer 6 (470-520 cm dt.)	**3**		**0**		**0**		**3**
Layer 7 (520-580 cm dt.)	**2**		**0**		**0**		**2**
Layer 8 (580-720 cm dt.)	**9**	90	**0**		**1**		**10**
Layer 9 (620-740 cm dt.)	**4**		**0**		**0**		**4**
Total	**44**	94	**1**	2	**2**	4	**47**

Table 4.5.5.2 The raw materials of atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Numerous atypical small tools are in gray sandstone (nearly 95%: 44/47). Only one or two specimens are in black sandstone and siliceous shale in the studied sectors (**Table 4.5.5.2**).

2) Measurements

Measurement **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Length (mm)**	**Width (mm)**	**Thickness (mm)**	**Number of atypical small tools**
Layer 3 (320-640 cm dt.)	64	47	24	13
Layer 4 (340-700 cm dt.)	72	50	30	13
Layer 5 (400-470 cm dt.)	78	44	28	2
Layer 6 (470-520 cm dt.)	57	39	20	3
Layer 7 (520-580 cm dt.)	62	49	19	2
Layer 8 (580-720 cm dt.)	72	52	25	10
Layer 9 (620-740 cm dt.)	73	57	39	4
Average	**69**	**49**	**27**	**47**

Table 4.5.5.3 Average dimensions of atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The average measurements of the atypical small tools are smaller than those of the scrapers. The average length for all the layers together is 69 mm; the longest is in the layer 5 (78 mm) and the shortest in the layer 6 (57 mm). The average width is 49 mm; the widest is in the layer 9 (57 mm) and the narrowest in the layer 6 (39 mm). The average thickness is around 27 mm. These tools appear slightly bigger in the lower layer 9 (but 4 specimens only), apart from the two ones from layer 5, which are quite long **(Table 4.5.5.3, figures 4.5.5.4 & 4.5.5.5)**

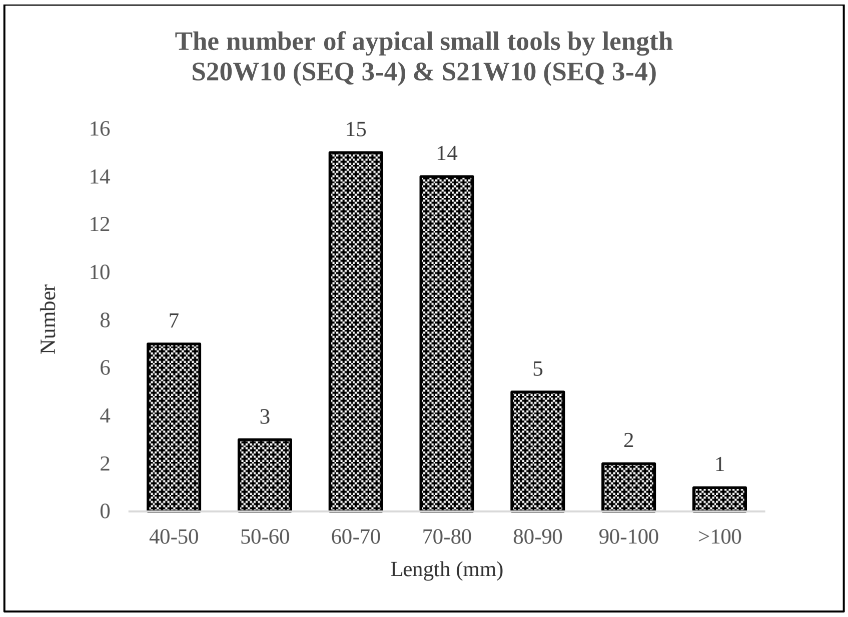


Figure 4.5.5.1 Distribution of the length of the atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

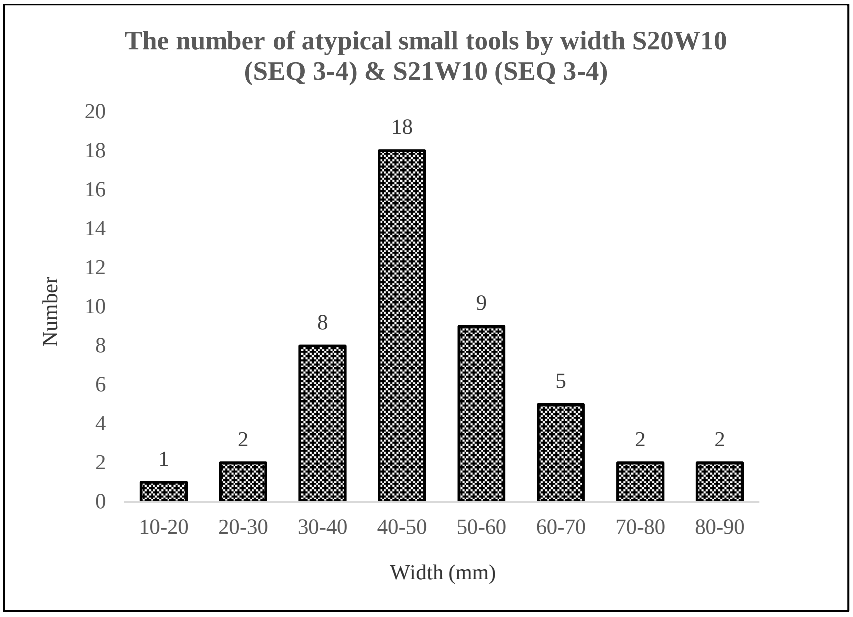


Figure 4.5.5.2 Distribution of the width of the atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

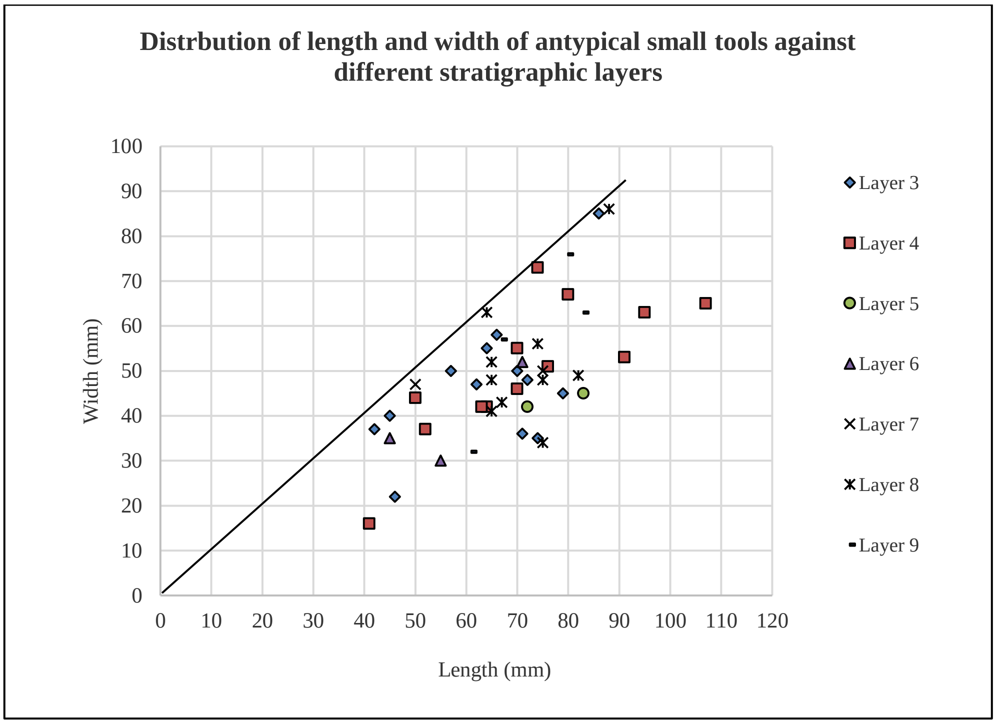


Figure 4.5.5.3 Scatter diagram length x width of the atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

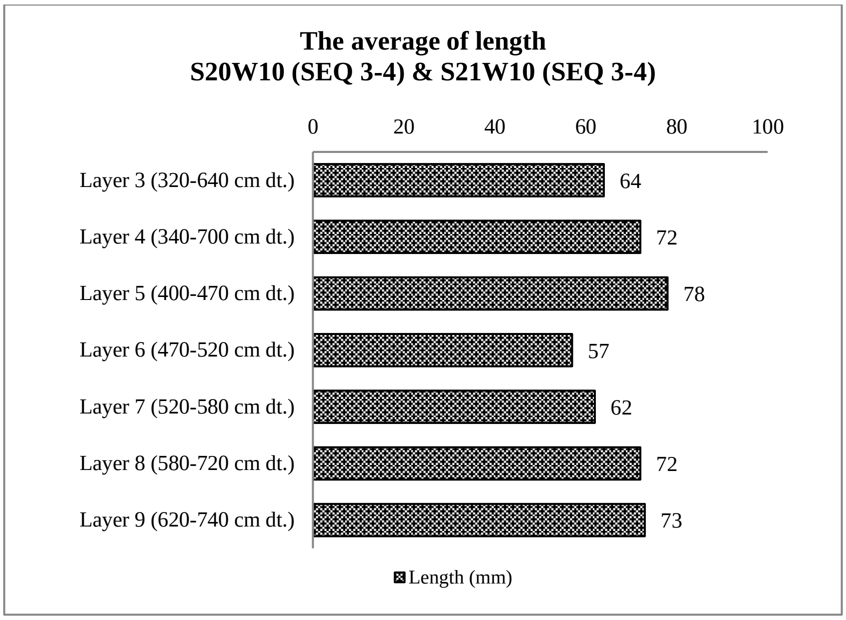


Figure 4.5.5.4 Distribution of the length average of the atypical small tools across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

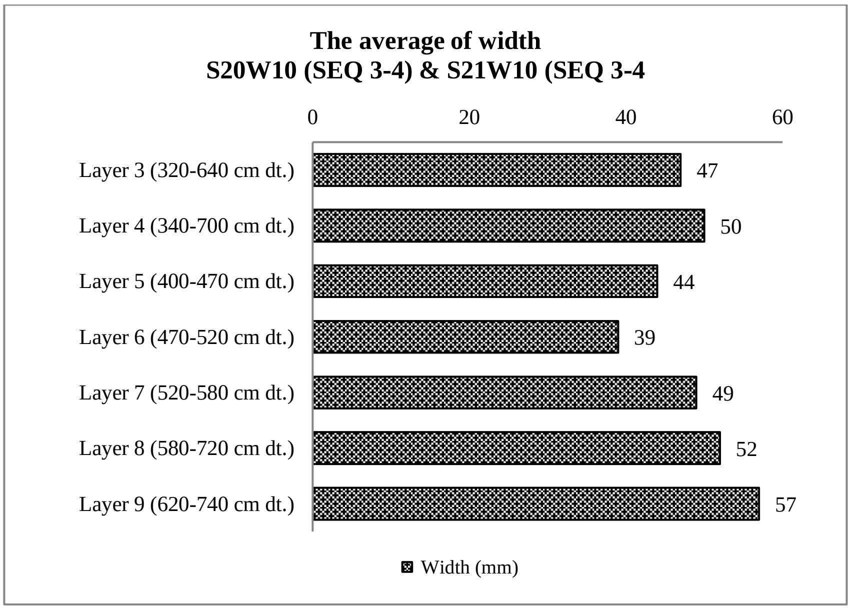


Figure 4.5.5.5 Distribution of the width average of the atypical small tools across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Weight (gr.) **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**<100**	**101-200**	**201-300**	**301-400**	**>400**	**Total**
Layer 3 (320-640 cm dt.)	8	4	0	0	1	**13**
Layer 4 (340-700 cm dt.)	5	4	4	0	0	**13**
Layer 5 (400-470 cm dt.)	1	1	0	0		**2**
Layer 6 (470-520 cm dt.)	2	1	0	0	0	**3**
Layer 7 (520-580 cm dt.)	2	0	0	0	0	**2**
Layer 8 (580-720 cm dt.)	6	2	1	1	0	**10**
Layer 9 (620-740 cm dt.)	1	0	2	1	0	**4**
Total	**25**	**12**	**7**	**2**	**1**	**47**

Table 4.5.5.4 The weight (in gram) of atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

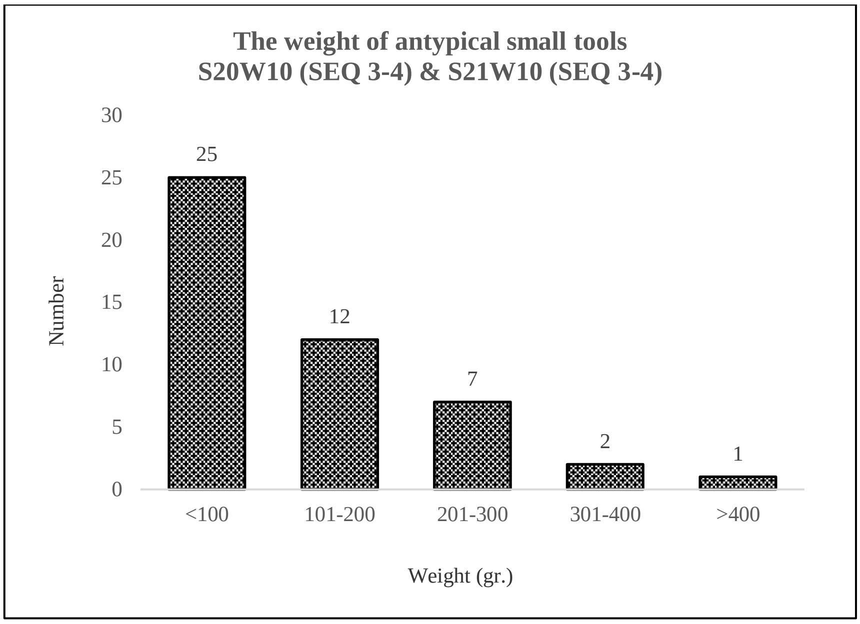


Figure 4.5.5.6 Distribution of the weight (in gram) of atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Weights of the atypical small tools are concentrated in the values less than 100 g (25 tools: 53%) and their frequency decreases up to more than 400 g, with a maximal weight around 470 g in the layer 3 **(Table 4.5.5.4, figure 4.5.5.6)**.

3) Supports

The supports of the atypical small tools are mostly broken cobbles (32%: 15/47) and then flakes (19%: 9/47) or cobble and pebble fragments (24%: 11/47; **Table 4.5.5.5, figure 4.5.5.7)**.

Supports **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Broken cobble**		**Cobble fragment**		**Whole cobble**		**Broken pebble**		**Pebble fragment**		**Split pebble**		**Whole pebble**		**Flake**		**Fragment**		**Total**
Layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3	**3**		**1**		**1**		**0**		**5**	38	**0**		**1**		**2**		**0**		**13**
Layer 4	**4**		**2**		**0**		**0**		**1**		**0**		**1**		**3**		**2**		**13**
Layer 5	**1**		**0**		**0**		**0**		**0**		**0**		**0**		**1**		**0**		**2**
Layer 6	**1**		**0**		**0**		**0**		**0**		**0**		**0**		**2**		**0**		**3**
Layer 7	**0**		**1**		**0**		**1**		**0**		**0**		**0**		**0**		**0**		**2**
Layer 8	**3**		**1**		**1**		**0**		**0**		**1**		**0**		**1**		**3**		**10**
Layer 9	**3**		**0**		**0**		**0**		**0**		**0**		**1**		**0**		**0**		**4**
Total	**15**	32	**5**	11	**2**		**1**		**6**	13	**1**		**3**		**9**	19	**5**	11	**47**

Table 4.5.5.5 The supports of atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

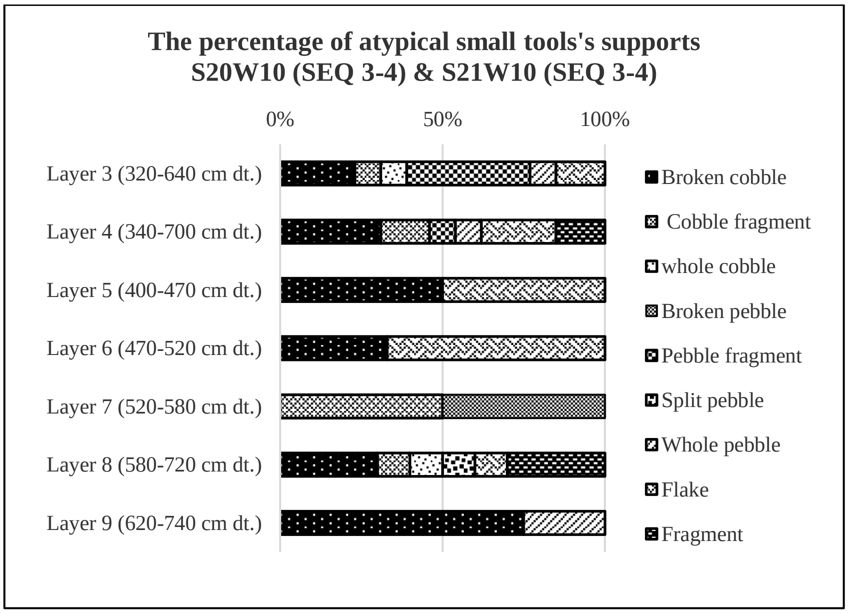


Figure 4.5.5.7 Distribution of the supports of atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4) General morphology of atypical small tools

4.1) Frontal view

Frontal view **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Trapezoidal**		**Irregular**		**Oval**		**Half-oval**		**Triangular**		**D-shape**		**Pentagonal**		**Circular**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**4**		**3**		**1**		**1**		**0**		**0**		**0**		**13**
Layer 4 (340-700 cm dt.)	**5**	39	**3**		**1**		**2**		**1**		**1**		**0**		**0**		**13**
Layer 5 (400-470 cm dt.)	**0**		**1**		**1**		**0**		**0**		**0**		**0**		**0**		**2**
Layer 6 (470-520 cm dt.)	**0**		**2**		**0**		**0**		**0**		**1**		**0**		**0**		**3**
Layer 7 (520-580 cm dt.)	**1**		**0**		**0**		**1**		**0**		**0**		**0**		**0**		**2**
Layer 8 (580-720 cm dt.)	**2**		**2**		**1**		**1**		**2**		**0**		**1**		**0**		**10**
Layer 9 (620-740 cm dt.)	**2**		**1**		**1**		**0**		**0**		**0**		**0**		**1**		**4**
Total	**14**	30	**13**	28	**7**	15	**5**	11	**4**	4/47	**2**		**1**		**1**		**47**

Table 4.5.5.6 The frontal view of atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4.2) Transversal view

Transversal view **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Trapezoidal**		**Irregular**		**Oval**		**Triangular**		**Half-oval**		**D-shape**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**5**	39	**2**		**3**		**2**		**1**		**0**		**13**
Layer 4 (340-700 cm dt.)	**4**		**4**		**2**		**1**		**1**		**1**		**13**
Layer 5 (400-470 cm dt.)	**0**		**0**		**0**		**2**		**0**		**0**		**2**
Layer 6 (470-520 cm dt.)	**0**		**2**		**1**		**0**		**0**		**0**		**3**
Layer 7 (520-580 cm dt.)	**1**		**0**		**1**		**0**		**0**		**0**		**2**
Layer 8 (580-720 cm dt.)	**4**		**2**		**3**		**1**		**0**		**0**		**10**
Layer 9 (620-740 cm dt.)	**1**		**0**		**0**		**2**		**1**		**0**		**4**
Total	**15**	32	**10**	22	**10**	22	**8**	17	**3**	3/47	**1**		**47**

Table 4.5.5.7 The transversal view of atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

As for the scrapers, the frontal view of the atypical small tools is mostly trapezoidal and irregular (around 30% each; **Table 4.5.5.6)**.

In transversal view, the atypical small tools are mostly trapezoidal (32%: 15/47), and the oval and irregular shapes are the second position (22% each: 10/47; **Table 4.5.5.7)**.

5) Shaping of the atypical small tools

5.1) Amount of cortex

- *On the upper face*

Amount of cortex **S20W10 (SEQ 3-4) &** **S21W10 (SEQ 3-4)**	**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**8**	61	**4**		**1**		**13**
Layer 4 (340-700 cm dt.)	**2**		**7**	54	**4**		**13**
Layer 5 (400-470 cm dt.)	**1**		**0**		**1**		**2**
Layer 6 (470-520 cm dt.)	**1**		**2**		**0**		**3**
Layer 7 (520-580 cm dt.)	**1**		**0**		**1**		**2**
Layer 8 (580-720 cm dt.)	**4**		**2**		**4**		**10**
Layer 9 (620-740 cm dt.)	**2**		**2**		**0**		**4**
Total	**19**	40	**17**	36	**11**	24	**47**

Table 4.5.5.8 Amount of cortex on upper face of the atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

- *On the lower face*

Amount of cortex **S20W10 (SEQ 3-4) &** **S21W10 (SEQ 3-4)**	**Totally cortical**		**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**5**	39	**3**		**3**		**2**		**13**
Layer 4 (340-700 cm dt.)	**1**		**4**		**6**	46	**2**		**13**
Layer 5 (400-470 cm dt.)	**2**		**0**		**0**		**0**		**2**
Layer 6 (470-520 cm dt.)	**0**		**2**		**1**		**0**		**3**
Layer 7 (520-580 cm dt.)	**2**		**0**		**0**		**0**		**2**
Layer 8 (580-720 cm dt.)	**3**		**0**		**6**	60	**1**		**10**
Layer 9 (620-740 cm dt.)	**3**		**0**		**1**		**0**		**4**
Total	**16**	34	**9**	19	**17**	36	**5**	11	**47**

Table 4.5.5.9 Amount of cortex on lower face of the atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Upper face of the typical small tools is mostly "cortical dominant" (40%: 19/47), especially in the layer 3 (61%: 8/13), and then "non-cortical dominant" (36%; 17/47), rather in the layer 4 (54%: 7/13). The "non-cortical" lower faces are less frequent (24% (11/47; **Table 4.5.5.8)**.

On the lower face, the atypical small tools are quite often "non-cortical dominant" (36%: 17/47) or "totally cortical" (34%: 16/47). The "cortical dominant" feature is less and mostly occurs in the upper layers **(Table 4.5.5.9)**.

5.2) Number of removals (shaping the tools)

- On the upper face

Number of removals S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	1	2	3	4	Total number of atypical small tools	Total number of removals	Average number of removals (total number of removals / total number of tools)
Layer 3	2	3	6	2	**13**	**34**	2,6
Layer 4	3	7	1	2	**13**	**28**	2,1
Layer 5	0	1	1	0	**2**	**5**	2,5
Layer 6	1	1	1	0	**3**	**6**	2,0
Layer 7	0	1	1	0	**2**	**5**	2,5
Layer 8	3	5	1	1	**10**	**20**	2,0
Layer 9	1	2	1	0	**4**	**8**	2,0
Total	**10**	**20**	**12**	**5**	**47**	**106**	2,3

Table 4.5.5.10 Number of removals on upper face of the atypical small tools from Tham Lod Rockshelter, area 2 sector S21W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The number of removals which are shaping the atypical small tools on their upper face is mainly 2 (43%: 20/47) or 3 removals (26%: 12/47). It is never more than 4. The average number in all the stratigraphic layers is around 2.3 **(Tables 4.5.5.10)**.

On the lower face the number of removals is of 1 or 2 **(Table 4.5.5.11)**.

- On the lower face

Number of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**1**	**2**	Total number of atypical small tools	Total number of removals	Average number of removals (total number of removals / total number of tools)
Layer 3 (320-640 cm dt.)	1	3	**4**	**6**	1.5
Layer 4 (340-700 cm dt.)	3	1	**4**	**5**	1.3
Layer 5 (400-470 cm dt.)	1	0	**1**	**1**	1
Layer 6 (470-520 cm dt.)	2	0	**2**	**2**	1
Layer 8 (580-720 cm dt.)	3	1	**4**	**5**	1.3
Layer 9 (620-740 cm dt.)	1	0	**1**	**1**	1
Total	**12**	**8**	**16**	**20**	1.3

Table 4.5.5.11 Number of removals on lower face of the atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

5.3) Direction of removals

- On the upper face

Direction of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Unipolar**		**Bipolar-opposite**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**10**	77	**3**		**13**
Layer 4 (340-700 cm dt.)	**12**	92	**1**		**13**
Layer 5 (400-470 cm dt.)	**1**		**1**		**2**
Layer 6 (470-520 cm dt.)	**2**		**1**		**3**
Layer 7 (520-580 cm dt.)	**2**		**0**		**2**
Layer 8 (580-720 cm dt.)	**9**	90	**1**		**10**
Layer 9 (620-740 cm dt.)	**3**		**1**		**4**
Total	**39**		**8**		**47**

Table 4.5.5.12 Direction of removals on upper face of the atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

- *On the lower face*

Direction of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Unipolar**		**Total**
Stratigraphic layers	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**4**
Layer 4 (340-700 cm dt.)	**4**		**4**
Layer 5 (400-470 cm dt.)	**1**		**1**
Layer 6 (470-520 cm dt.)	**2**		**2**
Layer 8 (580-720 cm dt.)	**4**		**4**
Layer 9 (620-740 cm dt.)	**1**		**1**
Total	**16**		**16**

Table 4.5.5.13 The direction of removals on lower face of the atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The large majority of atypical small tools are shaped by removals of unipolar unidirectional pattern on upper face (39/47: 83%) as well as on lower face (100%), corresponding to shaping of one side only. The bipolar-opposite pattern (8/47: 17%) indicates that two sides are shaped (**Tables 4.5.5.12 and 4.5.5.13)**.

5.4) Length of the longest removal

- *On the upper face*

Longest removal **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**8-10**	**11-20**	**21-30**	**31-40**	Total number of atypical small tools	Average maximal length (mm)
Layer 3 (320-640 cm dt.)	2	3	7	1	**13**	21
Layer 4 (340-700 cm dt.)	0	3	8	2	**13**	25
Layer 5 (400-470 cm dt.)	0	0	2	0	**2**	24
Layer 6 (470-520 cm dt.)	0	0	2	1	**3**	26
Layer 7 (520-580 cm dt.)	1	1	0	0	**2**	16
Layer 8 (580-720 cm dt.)	0	4	4	2	**10**	24
Layer 9 (620-740 cm dt.)	0	1	2	1	**4**	26
Total	**3**	**12**	**25**	**7**	**47**	

Table 4.5.5.14 Length of the longest removal (in mm) on upper face of atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

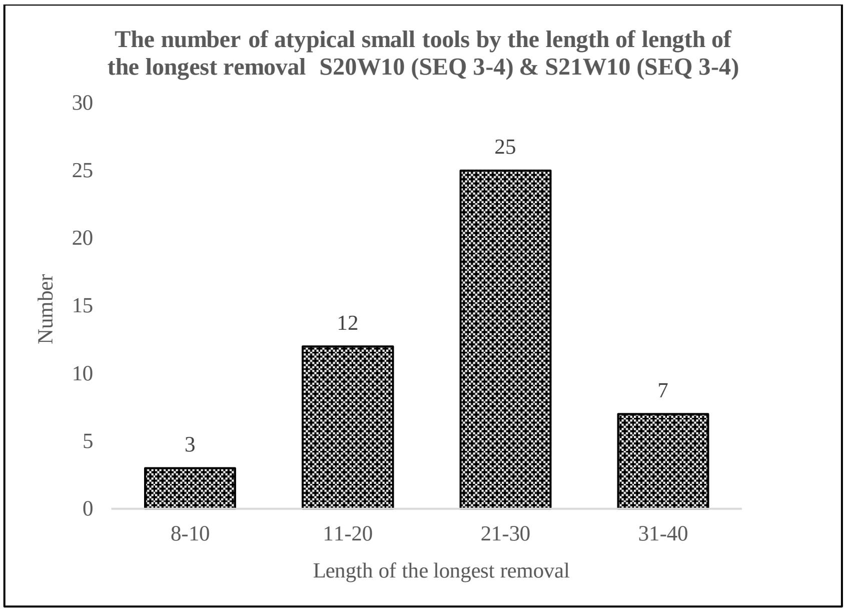


Figure 4.5.5.8 Distribution of length of the longest removal (in mm) on upper face of atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The length of the longest removal on the upper face varies between 8 and 35 mm with an average around 25 mm. The maximal longest length is in the layers 4 and 9 (35 mm). On the lower face, the longest removals are slightly shorter **(Tables 4.5.5.14 and 4.5.5.15 , figure 4.5.5.8)**.

- *On the lower face*

Longest lengths **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**5-10**	**11-20**	**21-30**	Total number of atypical small tools	Average maximal length
Layer 3 (320-640 cm dt.)	3	0	1	**4**	11
Layer 4 (340-700 cm dt.)	1	2	1	**4**	15
Layer 5 (400-470 cm dt.)	0	1	0	**1**	20
Layer 6 (470-520 cm dt.)	1	1	0	**2**	15
Layer 8 (580-720 cm dt.)	1	3	0	**4**	17
Layer 9 (620-740 cm dt.)	0	1	0	**1**	18
Total	**6**	**8**	**2**	**16**	

Table 4.5.5.15 Length of the longest removals on lower face of the atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

6) Morpho-functional features of atypical small tools: Nature of the edges

6.1) Nature of the lateral edges

Right edge **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Retouch Unifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**5**	38	**3**		**1**		**0**		**13**
Layer 4 (340-700 cm dt.)	**2**		**4**		**5**	38	**1**		**1**		**13**
Layer 5 (400-470 cm dt.)	**1**		**0**		**1**		**0**		**0**		**2**
Layer 6 (470-520 cm dt.)	**1**		**1**		**1**		**0**		**0**		**3**
Layer 7 (520-580 cm dt.)	**0**		**1**		**1**		**0**		**0**		**2**
Layer 8 (580-720 cm dt.)	**2**		**4**		**3**		**1**		**0**		**10**
Layer 9 (620-740 cm dt.)	**3**		**0**		**1**		**0**		**0**		**4**
Total	**13**	28	**15**	32	**15**	32	**3**		**1**		**47**

Left edge **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Retouch Unifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**3**		**4**		**5**	38	**1**		**0**		**13**
Layer 4 (340-700 cm dt.)	**4**		**2**		**6**	46	**0**		**1**		**13**
Layer 5 (400-470 cm dt.)	**1**		**0**		**1**		**0**		**0**		**2**
Layer 6 (470-520 cm dt.)	**2**		**0**		**1**		**0**		**0**		**3**
Layer 7 (520-580 cm dt.)	**0**		**0**		**2**		**0**		**0**		**2**
Layer 8 (580-720 cm dt.)	**1**		**2**		**6**	60	**1**		**0**		**10**
Layer 9 (620-740 cm dt.)	**2**		**0**		**2**		**0**		**0**		**4**
Total	**13**	28	**8**	17	**23**	49	**2**		**1**		**47**

Table 4.5.5.16 Nature of the lateral (right and left) edges of the atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The atypical small tools are more often shaped or retouched on their left edge (55%: 26/47) than on their right edge (40%: 19/47). When not shaped, the lateral sides are cortical or made up of a fracture, then more frequent on the right edge (**Table 4.5.5.16**).

6.2) Nature of the distal edge

Distal edge **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Pointed**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**1**		**2**		**9**	69	**1**		**0**		**13**
Layer 4 (340-700 cm dt.)	**5**	38	**3**		**4**		**0**		**1**		**13**
Layer 5 (400-470 cm dt.)	**0**		**0**		**2**		**0**		**0**		**2**
Layer 6 (470-520 cm dt.)	**2**		**0**		**1**		**0**		**0**		**3**
Layer 7 (520-580 cm dt.)	**1**		**0**		**1**		**0**		**0**		**2**
Layer 8 (580-720 cm dt.)	**2**		**3**		**2**		**3**		**0**		**10**
Layer 9 (620-740 cm dt.)	**2**		**0**		**2**		**0**		**0**		**4**
Total	**13**	28	**8**	17	**21**	45	**4**		**1**		**47**

Table 4.5.5.17 Nature of the distal edge of the atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The nature of the distal edge of the atypical small tools is very similar to that of the left edge, mostly shaped or retouched (55%; 26/47), usually on one face, rarely bifacially; one of the tools displays a point at the distal end. Cortex or fracture are observed on the blank (unshaped) edges **(Table 4.5.5.17)**.

6.3) Nature of the proximal edge

Proximal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**1**		**7**	54	**4**		**1**		**13**
Layer 4 (340-700 cm dt.)	**4**		**5**	38	**4**		**0**		**13**
Layer 5 (400-470 cm dt.)	**1**		**0**		**1**		**0**		**2**
Layer 6 (470-520 cm dt.)	**0**		**1**		**2**		**0**		**3**
Layer 7 (520-580 cm dt.)	**0**		**1**		**1**		**0**		**2**
Layer 8 (580-720 cm dt.)	**5**	50	**3**		**1**		**1**		**10**
Layer 9 (620-740 cm dt.)	**2**		**0**		**1**		**1**		**4**
Total	**13**	28	**17**	36	**14**	30	**3**		**47**

Table 4.5.5.18 Nature of the proximal edge of the atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

In the proximal position, the nature of the edge resembles that of the right edge, with a majority of fracture (36%: 17/47) and slightly less shaping **(Table 4.5.5.18)**.

7) Morpho-functional features of atypical small tools: Angle of the edges

7.1) Angle of right and left edges

Right side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep - inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**7**	54	**3**		**3**		**0**		**13**
Layer 4 (340-700 cm dt.)	**7**	54	**3**		**2**		**1**		**13**
Layer 5 (400-470 cm dt.)	**2**		**0**		**0**		**0**		**2**
Layer 6 (470-520 cm dt.)	**0**		**3**		**0**		**0**		**3**
Layer 7 (520-580 cm dt.)	**1**		**0**		**1**		**0**		**2**
Layer 8 (580-720 cm dt.)	**4**		**0**		**3**		**3**		**10**
Layer 9 (620-740 cm dt.)	**0**		**1**		**1**		**2**		**4**
Total	**21**	45	**10**	21	**10**	21	**6**	13	**47**

Left side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**5**	39	**2**		**4**		**2**		**13**
Layer 4 (340-700 cm dt.)	**3**		**6**	46	**4**		**0**		**13**
Layer 5 (400-470 cm dt.)	**1**		**1**		**0**		**0**		**2**
Layer 6 (470-520 cm dt.)	**2**		**1**		**0**		**0**		**3**
Layer 7 (520-580 cm dt.)	**1**		**0**		**1**		**0**		**2**
Layer 8 (580-720 cm dt.)	**5**	50	**2**		**2**		**1**		**10**
Layer 9 (620-740 cm dt.)	**0**		**1**		**0**		**3**		**4**
Total	**17**	36	**13**	28	**11**	23	**6**	13	**47**

Table 4.5.5.19 Angle of right and lefts edges of the atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The right and left edges, although not shaped in equal frequency, are both quite acute (45% and 36% respectively), probably due to fractures besides removals. Then they are oblique or steep (medium to open angled; 23% each in total) (**Table 4.5.5.19)**.

7.2) Angle of distal edge

Distal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Very-Acute**		**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**0**		**8**	62	**2**		**2**		**1**		**13**
Layer 4 (340-700 cm dt.)	**1**		**4**		**3**		**4**		**1**		**13**
Layer 5 (400-470 cm dt.)	**0**		**1**		**1**		**0**		**0**		**2**
Layer 6 (470-520 cm dt.)	**0**		**1**		**0**		**2**		**0**		**3**
Layer 7 (520-580 cm dt.)	**0**		**2**		**0**		**0**		**0**		**2**
Layer 8 (580-720 cm dt.)	**1**		**8**	73	**0**		**1**		**1**		**10**
Layer 9 (620-740 cm dt.)	**0**		**1**		**1**		**1**		**0**		**3**
Total	**2**	4	**25**	53	**7**	15	**10**	21	**3**	7	**47**

Table 4.5.5.20 Angle of distal edge of the atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The distal edge of the atypical small tools is acute or even very acute in more than 50% of the cases. The other edges are steep (open angled; 28%) or medium angled (**Table 4.5.5.20**).

7.3) Angle of proximal edge

Proximal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep - inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**5**	39	**3**		**3**		**2**		**13**
Layer 4 (340-700 cm dt.)	**4**		**5**	38	**4**		**0**		**13**
Layer 5 (400-470 cm dt.)	**1**		**1**		**0**		**0**		**2**
Layer 6 (470-520 cm dt.)	**0**		**3**		**0**		**0**		**3**
Layer 7 (520-580 cm dt.)	**0**		**1**		**1**		**0**		**2**
Layer 8 (580-720 cm dt.)	**3**		**2**		**4**		**1**		**10**
Layer 9 (620-740 cm dt.)	**0**		**0**		**2**		**2**		**4**
Total	**13**	28	**15**	32	**14**	30	**5**	10	**47**

Table 4.5.5.21 Angle of proximal edge of the atypical small tools from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The proximal edge is more oblique (medium angled: 32%; 15/47), then steep (open angled; 30%; 14/47) but also quite often acute (sharp angled; 28% 13/47; **Table 4.5.5.21)**.

4.6 Analysis of sumatraliths (large and small tools) from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) and S21W10 (SEQ 3-4)

4.6.1 General features of the sumatraliths

The typical and partial sumatraliths (large and small tools) represent 31% (248 specimens) of the studied material from the stratigraphic layers 3 to 10 of area 2, sectors S20W10 and S21W10. These implements were preliminary classified according to their size, as either large tool or small tool (longer or shorter than 10 cm). Considering the similarity between the large and small specimens, they have finally been studied together. All together, they consist of 117 typical sumatraliths and 131 partial sumatraliths **(Table 4.6.1.1)**. The typical sumatraliths are shaped or retouched all around on the upper face, and most of them are frequently found as non-cortical, without cortex on the surface. The partial sumatraliths are not shaped all around the upper face, they bear rather less removals, and the cortex extends more on the face. Generally, the partial sumatraliths are quite similar to the typical sumatraliths in shape.

Sumatraliths (large & small tools) **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Typical sumatraliths**				**Partial sumatraliths**				**Total**
	Large		Small		Large		Small		
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-340 cm dt.)	**26**	28	**11**	12	**32**	34	**25**	26	**94**
Layer 4 (340-400 cm dt.)	**35**	47	**6**	8	**25**	33	**9**	12	**75**
Layer 5 (400-470 cm dt.)	**2**		**2**		**3**		**0**		**7**
Layer 6 (470-520 cm dt.)	**3**		**7**	31	**12**	52	**1**		**23**
Layer 7 (520-580 cm dt.)	**5**	39	**1**		**5**	38	**2**		**13**
Layer 8 (580-620 cm dt.)	**6**	33	**5**	28	**4**		**3**		**18**
Layer 9 (620-700 cm dt.)	**5**	28	**3**	17	**9**	50	**1**		**18**
Total	**82**	33	**35**	14	**90**	36	**41**	17	**248**

Table 4.6.1.1 Distribution of the different types of sumatralith (large and small, typical and partial) in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Most of the sumatraliths occur in the upper layers 3 and 4, mainly the large typical and partial sumatraliths (nearly 50% of the total: 118 items); smaller specimens, especially the small partial sumatraliths are more conspicuous in the layer 3 (26%: 25/94). It is to be noted that in the layers 6 and 9, the large partial sumatraliths are preponderant (50-52%). There are no sumatraliths in the layer 10 of sectors S20W10 and S21W10. **(Table 4.6.1.1, figure 4.6.1.1)**.

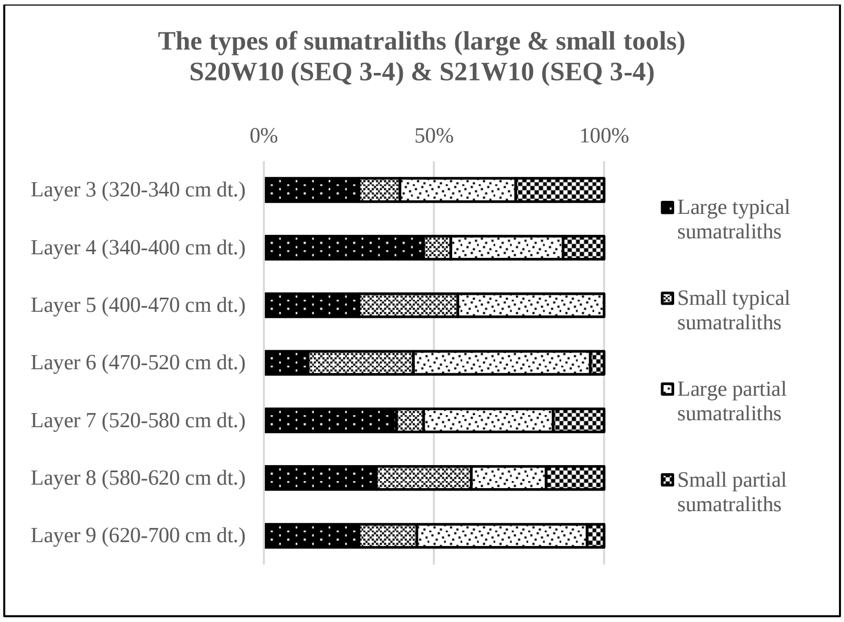


Figure 4.6.1.1 Distribution of the different types of sumatralith (large and small, typical and partial) in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Raw materials **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Gray sandstone**		**Black sandstone**		**Siliceous shale**		**Quartzite**		**Quartz**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**86**	92	**3**		**3**		**1**		**1**		**94**
Layer 4 (340-700 cm dt.)	**75**	100	**0**		**0**		**0**		**0**		**75**
Layer 5 (400-470 cm dt.)	**7**	100	**0**		**0**		**0**		**0**		**7**
Layer 6 (470- 520 cm dt.)	**22**	96	**1**		**0**		**0**		**0**		**23**
Layer 7 (520- 580 cm dt.)	**13**	100	**0**		**0**		**0**		**0**		**13**
Layer 8 (580-720 cm dt.)	**16**	89	**0**		**0**		**0**		**2**		**18**
Layer 9 (620-740 cm dt.)	**16**	89	**2**		**0**		**0**		**0**		**18**
Total	**235**	95	**6**	3	**3**		**1**		**3**		**248**

Table 4.6.1.2 The raw materials of sumatraliths (large & small tools) from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The large majority of sumatraliths (large and small tools) are in gray sandstone (235/248: 95%) just like the choppers and scrapers. The other raw materials such as black sandstone, siliceous shale, quartzite and quartz are seldom represented (5% of the sumatraliths) (**Table 4.6.1.2**)

Weight (gr.) **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4**	**<200**	**201-400**	**401-600**	**601-800**	**801-1000**	**1001-1200**	**1201-1400**	**1401-1600**	**>1600**	**Total**
Layer 3 (320-640 cm dt.)	23	33	23	9	2	1	1	1	1	**94**
Layer 4 (340-700 cm dt.)	15	27	26	5	1	0	1	0	0	**75**
Layer 5 (400-470 cm dt.)	4	1	1	1	0	0	0	0	0	**7**
Layer 6 (470- 520 cm dt.)	11	7	2	1	1	0	1	0	0	**23**
Layer 7 (520- 580 cm dt.)	4	3	3	1	1	1	0	0	0	**13**
Layer 8 (580-720 cm dt.)	5	3	3	2	3	1	0	1	0	**18**
Layer 9 (620-740 cm dt.)	7	5	4	0	0	1	0	0	1	**18**
Total	**69**	**79**	**62**	**19**	**8**	**4**	**3**	**2**	**2**	**248**

Table 4.6.1.3 The weight (in gram) of sumatraliths (large & small tools) from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The weight of sumatraliths (large & small tools) is well concentrated in the values less than 600 g (210 tools: 85% of the sumatraliths). They are lighter than the choppers whose weight often reach 1 kg, especially the end choppers which are heavier than the side choppers. The maximal weight (1700 g) is in the layers 3 and 9 **(Table 4.6.1.3, figure 4.6.1.2)**.

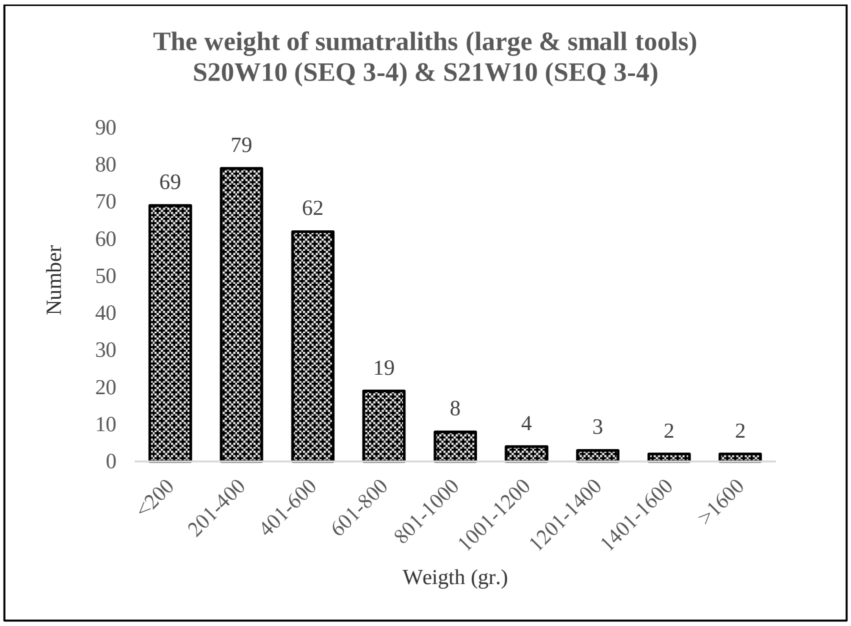


Figure 4.6.1.2 Distribution of the weight (in gram) of sumatraliths (large and small, typical and partial) from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4.6.2 Typical sumatraliths (large & small tools)

With a total of 117 (15% of the studied material), the typical sumatraliths are well represented from stratigraphic layers 3 to 9 of area 2 sectors S20W10 & S21W10. All of them usually belong to both categories of large and small tools (measuring more or less than 10 cm). They are commonly made on the oval and almond-shaped cobbles; they are shaped by flakes removed all around, on one face (upper face), leaving the surface on the other face (lower face).

1) General features of the typical sumatraliths

The proportion of typical sumatraliths among all the tools (large and small) reaches about 20% in the layers 6 to 4 (6: 10/45, 5: 4/21 and 4: 41/200). It is quite less, around 10%, in the lower layers, except the lowest layer 10 devoid of sumatraliths (9: 8/75, 8: 11/103 and 7: 6/66). In the upper layer 3 this proportion is around 16% (37/226) **(Table 4.6.2.1)**.

Typical sumatraliths **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Layer 3**		**Layer 4**		**Layer 5**		**Layer 6**		**Layer 7**		**Layer 8**		**Layer 9**		**Layer 10**		**Total**
Numbers (%)	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
S20W10 (SEQ 3-4)	**35**	28	**36**	53							**2**		**1**		**-**		**81**
S21W10 (SEQ 3-4)	**2**		**2**		**4**		**10**	25	**6**	15	**9**	22	**7**	18	**-**		**40**
S21W10 (SEQ 1-2)	**-**		**-**		**8**	35	**15**	65	**0**		**-**		**-**		**-**		**23**
S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**37**	14	**41**	20	**4**		**10**	22	**6**	9	**11**	11	**8**	10	**-**		**117**(15%)
All tools (large & small) S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**226**		**200**		**21**		**45**		**66**		**103**		**75**		**18**		**794**

Table 4.6.2.1 Distribution of typical sumatraliths in the stratigraphic sequence of Tham Lod Rockshelter and in the different studied sectors of area 2: sectors S20W10 (SEQ 3-4) and S21W10 (SEQ 3-4) as well as sector S21W10 (SEQ 1-2) for layers 7 to 5 only (which are missing in S20W10 as they correspond to a rock fall only occurring towards the shelter wall.

Raw materials **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Gray sandstone**		**Black sandstone**		**Siliceous shale**		**Quartz**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**32**	86	**1**		**1**		**3**		**37**
Layer 4 (340-700 cm dt.)	**41**	100	**0**		**0**		**0**		**41**
Layer 5 (400-470 cm dt.)	**4**	100	**0**		**0**		**0**		**4**
Layer 6 (470- 520 cm dt.)	**10**	100	**0**		**0**		**0**		**10**
Layer 7 (520- 580 cm dt.)	**6**	100	**0**		**0**		**0**		**6**
Layer 8 (580-720 cm dt.)	**9**	82	**0**		**2**		**0**		**11**
Layer 9 (620-740 cm dt.)	**8**	100	**0**		**0**		**0**		**8**
Total	**110**	94	**1**		**3**		**3**		**117**

Table 4.6.2.2 The raw materials of typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The preponderant raw material of typical sumatraliths, as of all the other artefacts from Tham Lod, is the gray sandstone representing nearly 95% for all the layers together (110/117) but actually 100% in most of them, except in the layers 3 and 8 where the siliceous shale, the quartz and the black sandstone are also used (**Table 4.6.2.2**).

2) Measurements

Measurement **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Length (mm)**	**Width (mm)**	**Thickness (mm)**	**Number of typical sumatraliths**
Layer 3 (320-640 cm dt.)	115	68	38	37
Layer 4 (340-700 cm dt.)	117	75	36	41
Layer 5 (400-470 cm dt.)	118	73	40	4
Layer 6 (470- 520 cm dt.)	91	69	35	10
Layer 7 (520- 580 cm dt.)	117	83	43	6
Layer 8 (580-720 cm dt.)	112	70	42	11
Layer 9 (620-740 cm dt.)	118	77	52	8
Average	**113**	**72**	**38**	**117**

Table 4.6.2.3 Average dimensions of typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Generally, the average length is steady between 112 and 118 mm in all the layers except in the layer 6 (91 mm), where the sumatraliths are especially small. Similarly, for the average width, values are quite equal throughout the stratigraphy: 68 to 77 mm, yet with a higher value and therefore wider specimens in the layer 7 (83 mm). Also, the overall average thickness is around 38 mm and seems to decrease from bottom to top of the stratigraphy (52 to 36 mm) **(Table 4.6.2.3, figures 4.6.2.4 & 4.6.2.5)**.

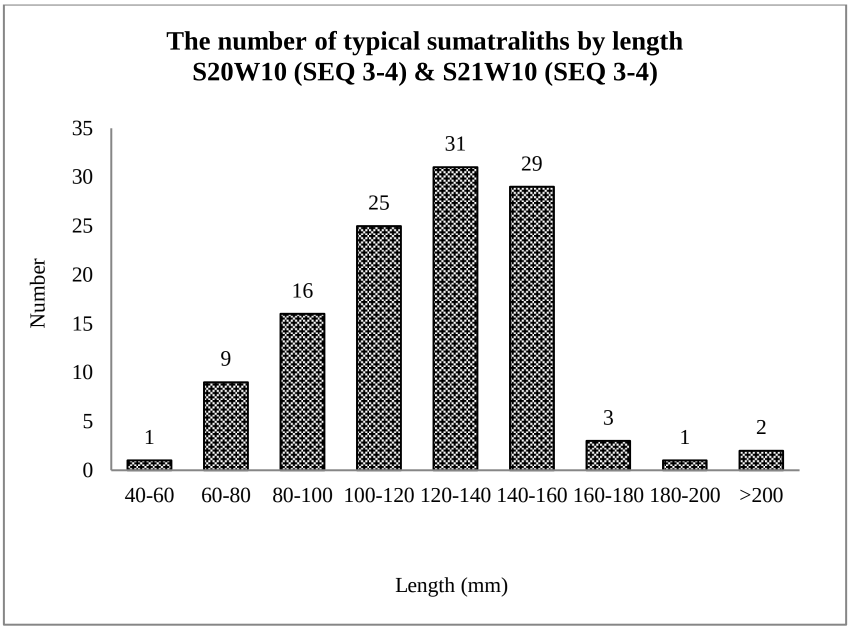


Figure 4.6.2.1 Distribution of the typical sumatraliths by length from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

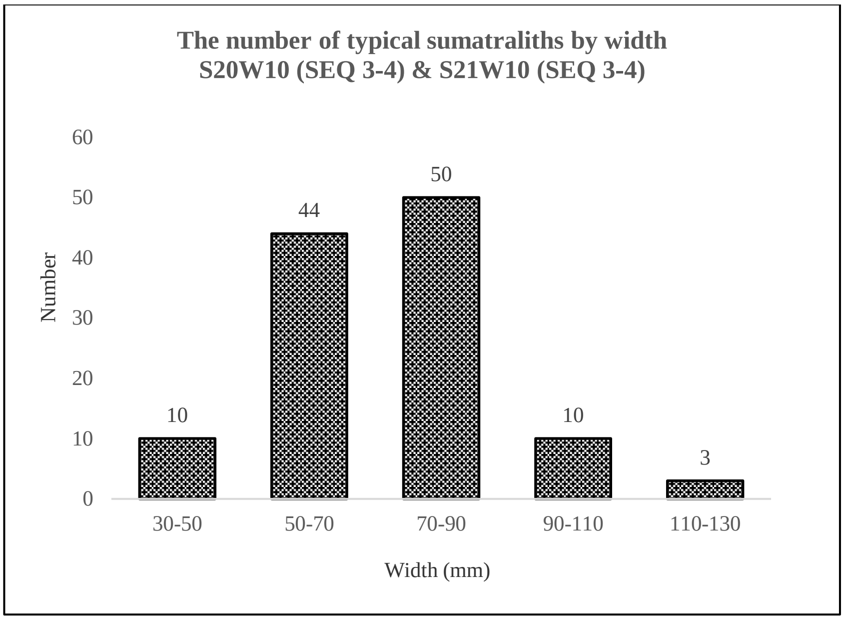


Figure 4.6.2.2 Distribution of the typical sumatraliths by width from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

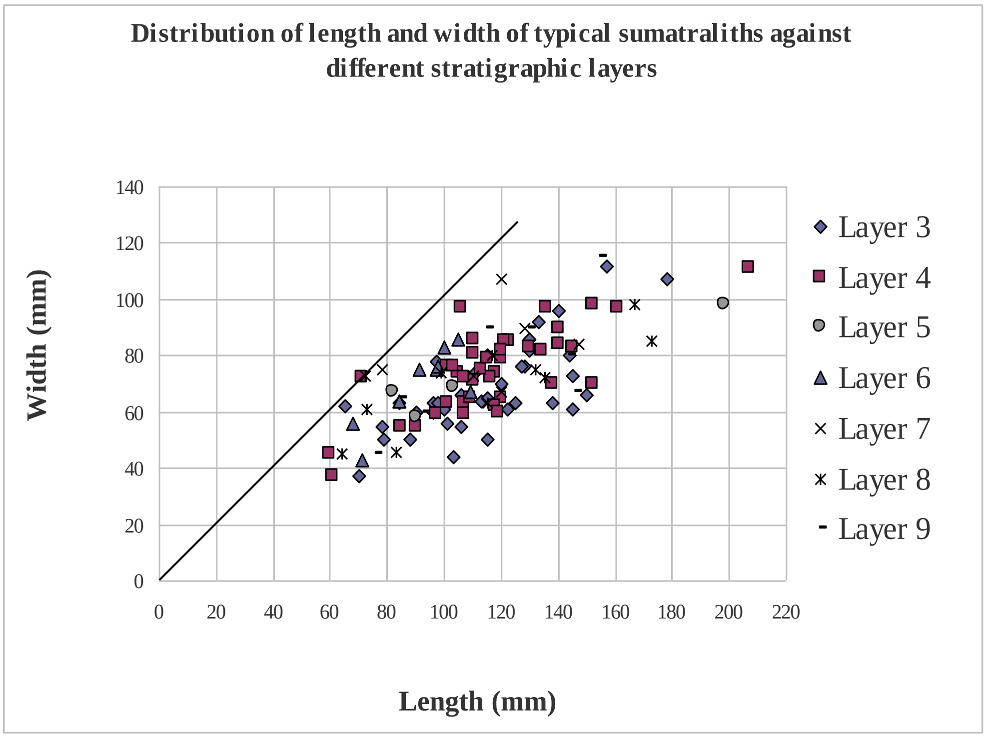


Figure 4.6.2.3 Scatter diagram length x width of the typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The length and width of typical sumatraliths provide unimodal histograms and therefore follow a normal distribution around the mean values. This type of tool makes up a rather homogenous group **(figures 4.6.2.1 and 4.6.2.2)**. Moreover, the scatter diagram of width versus length suggests that both these dimensions are approximately correlated: when the length increases the width tends to increase proportionally (**figure 4.6.2.3**).

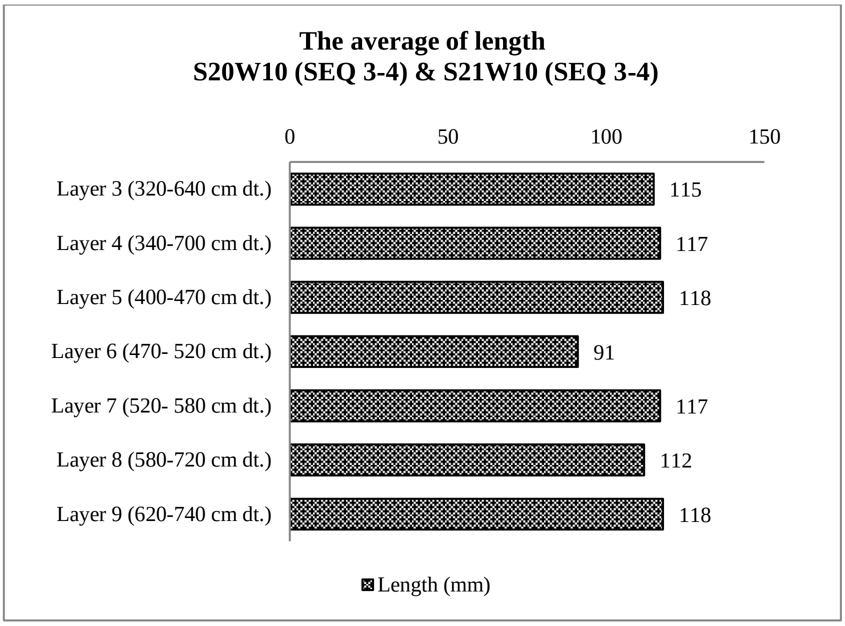


Figure 4.6.2.4 Distribution of the average length of the typical sumatraliths across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

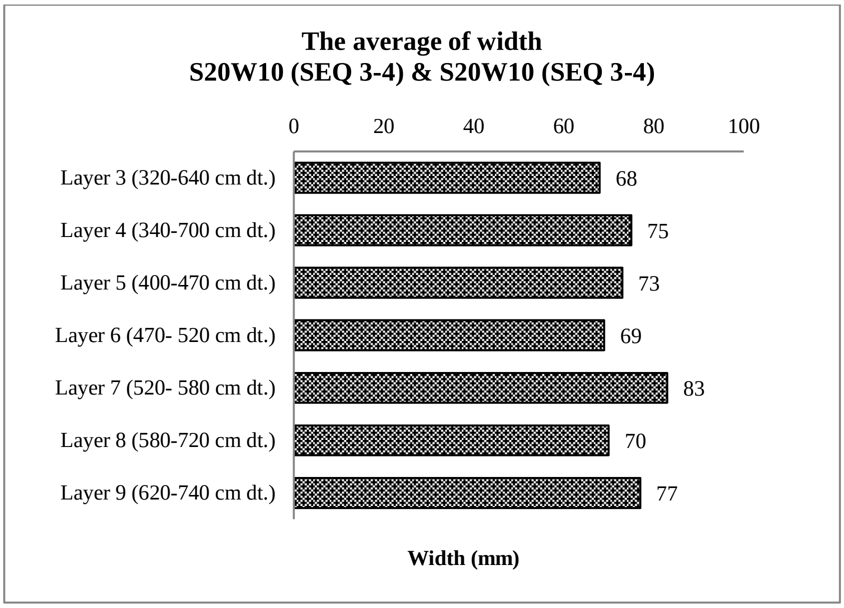


Figure 4.6.2.5 Distribution of the average width of the typical sumatraliths across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Weight (gr.) **S20W10 (SEQ 3-4)** **S21W10 (SEQ 3-4)**	**<200**	**201-400**	**401-600**	**601-800**	**801-1000**	**1001-1200**	**1201-1400**	**>1400**	**Total**
Layer 3 (320-640 cm dt.)	6	14	10	4	1	1	0	1	**37**
Layer 4 (340-700 cm dt.)	4	12	20	3	1	0	1	0	**41**
Layer 5 (400-470 cm dt.)	2	1	0	1	0	0	0	0	**4**
Layer 6 (470- 520 cm dt.)	4	3	2	0	1	0	0	0	**10**
Layer 7 (520- 580 cm dt.)	1	1	3	0	0	1	0	0	**6**
Layer 8 (580-720 cm dt.)	4	1	1	0	3	1	0	1	**11**
Layer 9 (620-740 cm dt.)	3	2	1	0	0	1	0	1	**8**
Total	**24**	**34**	**37**	**8**	**6**	**4**	**1**	**3**	**117**

Table 4.6.2.4 The weight (in gram) of typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The weight of typical sumatraliths ranges between less than 200 g and more than 1400 g, but it is concentrated between 201 and 600 g (60%: 71/117). The weight classes above 1.0 kg recover less than 10% (8 specimens), and the maximum weight is in the layer 9 (1700 g) **(Table 4.6.2.4, figure 4.6.2.6)**.

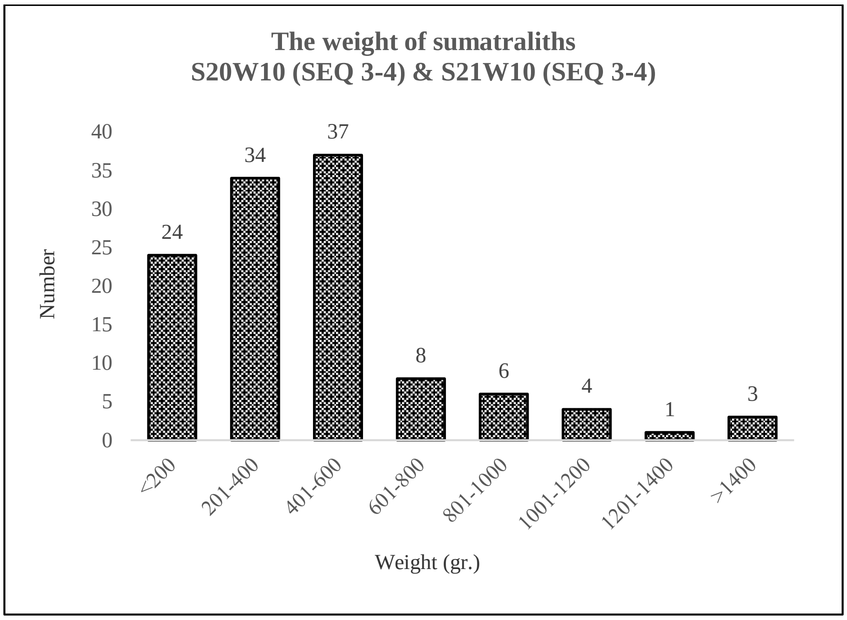


Figure 4.6.2.6 Distribution of the weight (in gram) of typical sumatraliths from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

3) Supports

The principal supports of the typical sumatraliths are whole cobbles, representing 55% (65/117) or indeterminate cobbles 18% (21/117) for which it is difficult to know whether they were complete, broken or split before being shaped. The latter are quite frequent in the upper layers 3 to 4: 22-24%. The other supports like cobble fragments, split cobbles, whole pebbles, flakes and fragments are less frequent, approximately 15% **(Table 4.6.2.5)**.

Supports **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Broken cobble**		**Cobble fragment**		**Whole cobble**		**Split cobble**		**Indeter-minate cobble**		**Whole pebble**		**Flake**		**Fragment**		**Total**
Layers	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**
Layer 3	**2**		**2**		**24**	65	**0**		**8**	22	**0**		**0**		**1**		**37**
Layer 4	**6**	15	**0**		**23**	56	**0**		**10**	24	**2**		**0**		**0**		**41**
Layer 5	**0**		**0**		**2**		**1**		**0**		**0**		**1**		**0**		**4**
Layer 6	**2**		**2**		**4**		**0**		**1**		**0**		**1**		**0**		**10**
Layer 7	**0**		**1**		**5**	83	**0**		**0**		**0**		**0**		**0**		**6**
Layer 8	**3**		**1**		**3**		**2**		**1**		**1**		**0**		**0**		**11**
Layer 9	**1**		**0**		**4**		**1**		**1**		**0**		**1**		**0**		**8**
Total	**14**	12	**6**	5	**65**	55	**4**		**21**	18	**3**		**3**		**1**		**117**

Table 4.6.2.5 The supports of typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

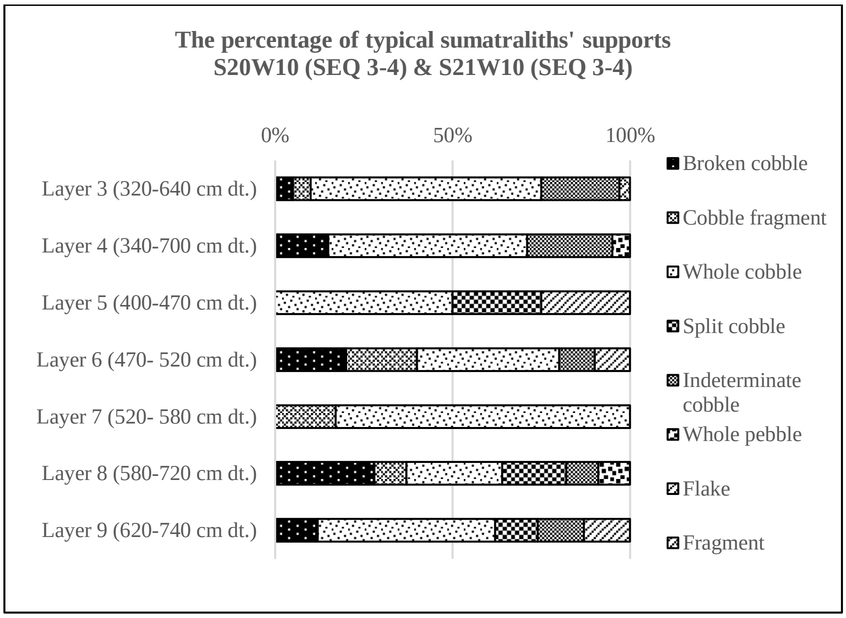


Figure 4.6.2.7 Distribution of the supports of typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4) General morphology of typical sumatraliths

4.1) Frontal view

Frontal view **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Oval**		**Irregular**		**Half-oval**		**Triangular**		**Trapezoidal**		**Almond**		**Circular**		**Pentagonal**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**31**	84	**3**		**2**		**1**		**0**		**0**		**0**		**0**		**37**
Layer 4 (340-700 cm dt.)	**36**	88	**1**		**1**		**0**		**1**		**2**		**0**		**0**		**41**
Layer 5 (400-470 cm dt.)	**0**		**3**		**1**		**0**		**0**		**0**		**0**		**0**		**4**
Layer 6 (470- 520 cm dt.)	**1**		**2**		**1**		**3**		**1**		**0**		**2**		**0**		**10**
Layer 7 (520- 580 cm dt.)	**2**		**3**		**0**		**0**		**1**		**0**		**0**		**0**		**6**
Layer 8 (580-720 cm dt.)	**1**		**7**	64	**1**		**0**		**0**		**1**		**0**		**1**		**11**
Layer 9 (620-740 cm dt.)	**2**		**1**		**0**		**2**		**2**		**0**		**1**		**0**		**108**
Total	**73**	63	**20**	17	**6**	5	**6**	5	**5**	4	**3**	3/117	**3**	3/117	**1**		**117**

Table 4.6.2.6 The frontal view of typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4.2) Transversal view

Transversal view **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Trapezoidal**		**Triangular**		**Oval**		**D-shape**		**Irregular**		**Half-oval**		**Pentagonal**		**Bi-convex**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**11**	30	**7**	19	**9**	24	**3**		**2**		**1**		**1**		**1**		**37**
Layer 4 (340-700 cm dt.)	**7**	17	**1**		**8**	19	**13**	32	**5**	12	**1**		**0**		**0**		**41**
Layer 5 (400-470 cm dt.)	**0**		**0**		**1**		**0**		**3**		**0**		**0**		**0**		**4**
Layer 7 (520- 580 cm dt.)	**1**		**5**	83	**0**		**0**		**0**		**0**		**0**		**0**		**6**
Layer 8 (580-720 cm dt.)	**8**	73	**0**		**1**		**1**		**1**		**0**		**0**		**0**		**11**
Layer 9 (620-740 cm dt.)	**5**	63	**0**		**0**		**0**		**0**		**1**		**2**		**0**		**8**
Total	**34**	29	**19**	16	**19**	16	**19**	16	**11**	9	**3**	3/117	**3**	3/117	**1**		**117**

Table 4.6.2.7 The transversal view of typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Only one main shape of typical sumatraliths such as oval (73/117: 63%) is noticeable in frontal view. There are variations among the layers, and this shape is particularly well represented in the upper layers 3 to 4: 84-88%. The other shapes are rare, except the irregular shape, which is eminent in the layer 8 **(Table 4.6.2.6)**.

In transversal view, the trapezoidal shape is more common than the other shapes (34/117: 29%), especially in the lower layers (layer 8, 73%: 8/11; layer 9, 63%: 5/8). The other shapes, like d-shape, oval and triangular are also well represented in these sectors **(Table 4.6.2.7)**.

5) Shaping of the typical sumatraliths

5.1) Amount of cortex

- On the upper face

Amount of cortex **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**12**	32	**11**	30	**14**	38	**37**
Layer 4 (340-700 cm dt.)	**4**		**22**	54	**15**	36	**41**
Layer 5 (400-470 cm dt.)	**2**		**0**		**2**		**4**
Layer 6 (470- 520 cm dt.)	**1**		**6**	60	**3**		**10**
Layer 7 (520- 580 cm dt.)	**4**		**2**		**0**		**6**
Layer 8 (580-720 cm dt.)	**5**	45	**0**		**6**	55	**11**
Layer 9 (620-740 cm dt.)	**5**	62	**1**		**2**		**8**
Total	**33**	28	**42**	36	**42**	36	**117**

Table 4.6.2.8 Amount of cortex on upper face of the typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

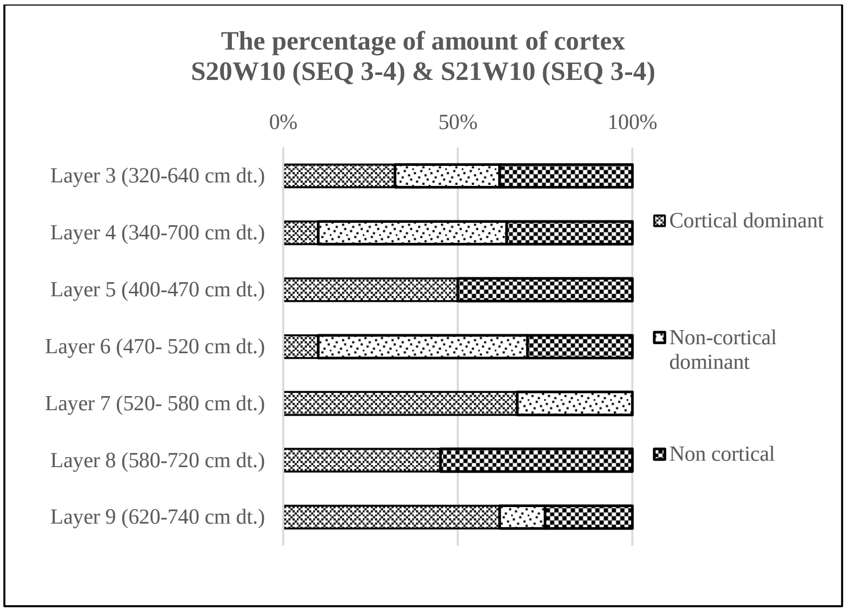


Figure 4.6.2.8 Distribution of the amount of cortex on the upper face of typical sumatraliths from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4)

The “non-cortical” and “non-cortical dominant” of typical sumatraliths are equally frequent on the upper face: 36% (42/117) and then, the “cortical dominant” is representing 28% (33/117). The shaping of the upper face of typical sumatraliths usually affects more than half of the surface **(Table 4.6.2.8, figure 4.6.2.8)**, and this is different from the choppers or scrapers where more than half of the upper faces are “cortical dominant”.

- *On the lower face*

Amount of cortex **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Totally cortical**		**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**26**	70	**9**	24	**1**		**1**		**37**
Layer 4 (340-700 cm dt.)	**30**	73	**9**	22	**2**		**0**		**41**
Layer 5 (400-470 cm dt.)	**2**		**2**		**0**		**0**		**4**
Layer 6 (470- 520 cm dt.)	**5**	50	**3**		**0**		**2**		**10**
Layer 7 (520- 580 cm dt.)	**4**		**1**		**0**		**1**		**6**
Layer 8 (580-720 cm dt.)	**5**	46	**3**		**1**		**2**		**11**
Layer 9 (620-740 cm dt.)	**4**		**0**		**1**		**3**		**8**
Total	**76**	65	**27**	23	**5**	4	**9**	8	**117**

Table 4.6.2.9 Amount of cortex on lower face of the typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

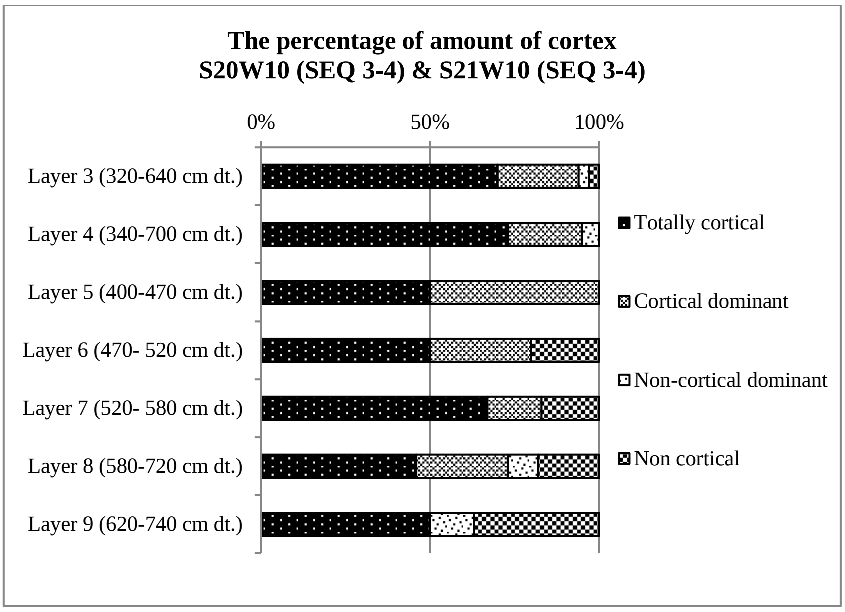


Figure 4.6.2.9 Distribution of the amount of cortex on the lower face of typical sumatraliths from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4)

The lower face of the typical sumatraliths is mostly "totally cortical", for 56% (76/117), or then "cortical dominant" about 23% (27/117). The "non-cortical" and "non-cortical dominant" patterns are less than 10% of the studied material **(Table 4.6.2.9, figure 4.6.2.9)**.

5.2) Number of removals (shaping the tools)

- On the upper face

Number of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**10**	**>10 (~15)**	Total number of typical sumatraliths	Total number of removals	Average number of removals (total number of removals / total number of tools)
Layer 3	1	0	0	0	0	1	0	2	33	**37**	**524**	14,2
Layer 4	0	0	0	0	0	0	0	1	40	**41**	**610**	14,9
Layer 5	0	0	1	0	0	2	1	0	0	**4**	**26**	6,5
Layer 6	0	0	0	1	2	0	1	0	6	**10**	**115**	11,5
Layer 7	0	3	0	0	1	0	0	0	2	**6**	**45**	7,5
Layer 8	1	2	0	1	0	1	1	0	5	**11**	**103**	9,4
Layer 9	2	0	1	0	0	0	0	2	3	**8**	**73**	9,1
Total	**4**	**5**	**2**	**2**	**3**	**4**	**3**	**5**	**89**	**117**	**1496**	12,8

Table 4.6.2.10 Number of removals on upper face of the typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The number of removals on the upper face of the typical sumatraliths is overwhelmingly found above 10 removals (76%: 89/117), and in the upper layers 3 to 4, they are globally preponderant (more than 65%).
The average number of removals shaping of the typical sumatraliths from all the layers is around 13 but this number is not really significant as it clearly increases from the lower layers to the upper layers, from 9 to 15 removals. Only in the layers 7 and 5, where these tools are very few, the number of removals is especially low **(Table 4.6.2.10)**. It is to be reminded that only the removals more than 5 mm long are counted, the smaller ones being considered as retouch.

- On the lower face

Number of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**1**	**2**	**3**	Total number of typical sumatralith with removals on the lower face	Total number of removals	Average number of removals (total number of removals / total number of tools)
Layer 5 (400-470 cm dt.)	1	0	1	**2**	**4**	2,0
Layer 7 (520-580 cm dt.)	1	1	0	**2**	**3**	1,5
Layer 8 (580-620 cm dt.)	1	0	0	**1**	**1**	1,0
Layer 9 (620-700 cm dt.)	1	0	0	**1**	**1**	1,0
Total	**4**	**1**	**1**	**6**	**9**	1,5

Table 4.6.2.11 Number of removals on lower face of the typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

A few typical sumatraliths also have some removals on the lower face, but never more than three removals **(Table 4.6.2.11)**.

5.3) Direction of removals

- On the upper face

Direction of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Unipolar**		**Bipolar-opposite**		**Bidirectional-orthogonal**		**Three-directions**		**Convergent**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**1**		**1**		**0**		**1**		**34**	92	**37**
Layer 4 (340-700 cm dt.)	**0**		**0**		**0**		**1**		**40**	98	**41**
Layer 5 (400-470 cm dt.)	**1**		**1**		**1**		**0**		**1**		**4**
Layer 6 (470- 520 cm dt.)	**0**		**1**		**2**		**3**		**4**		**10**
Layer 7 (520- 580 cm dt.)	**1**		**0**		**1**		**3**		**1**		**6**
Layer 8 (580-720 cm dt.)	**2**		**1**		**0**		**2**		**6**	55	**11**
Layer 9 (620-740 cm dt.)	**1**		**3**		**0**		**1**		**3**		**8**
Total	**6**	5	**7**	6	**4**		**11**	9	**89**	76	**117**

Table 4.6.2.12 Direction of removals on upper face of the typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

- On the lower face

Direction of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Unipolar**		**Total**
Stratigraphic layers	**N**	%	**N**
Layer 5 (400-470 cm dt.)	**2**		**2**
Layer 7 (520-580 cm dt.)	**2**		**2**
Layer 8 (580-620 cm dt.)	**1**		**1**
Layer 9 (620-700 cm dt.)	**1**		**1**
Total	**6**	100	**6**

Table 4.6.2.13 Direction of removals on lower face of the typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The large majority of typical sumatraliths are shaped by “convergent” removals (76%: 89/177), mainly in the upper layer 4 (98%: 40/41). The other pattern such as “unipolar”, “bipolar opposite” and “bidirectional orthogonal” and “three-directions”, which correspond to tools not shaped all around and only retouched on a part of their periphery, are rarely represented **(Table 4.6.2.12)**.

On the lower face, the very few removals are all unipolar unidirectional **(Table 4.6.2.13)**.

5.4) Length of the longest removal

- On the upper face

Longest removal **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**7-10**	**11-20**	**21-30**	**31-40**	**41-50**	**51-60**	**>60**	Total number of typical sumatraliths	Average maximal length (mm)
Layer 3 (320-640 cm dt.)	0	5	8	13	9	2	0	**37**	35
Layer 4 (340-700 cm dt.)	0	2	5	21	13	0	0	**41**	35
Layer 5 (400-470 cm dt.)	1	1	2	0	0	0	0	**4**	18
Layer 6 (470- 520 cm dt.)	1	0	3	2	4	0	0	**10**	33
Layer 7 (520- 580 cm dt.)	1	0	2	0	2	1	0	**6**	34
Layer 8 (580-720 cm dt.)	1	2	0	3	2	2	1	**11**	41
Layer 9 (620-740 cm dt.)	1	1	0	2	1	1	2	**8**	42
Total	**5**	**11**	**20**	**41**	**31**	**6**	**3**	**117**	

Table 4.6.2.14 Length of the longest removal (in mm) on upper face of typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

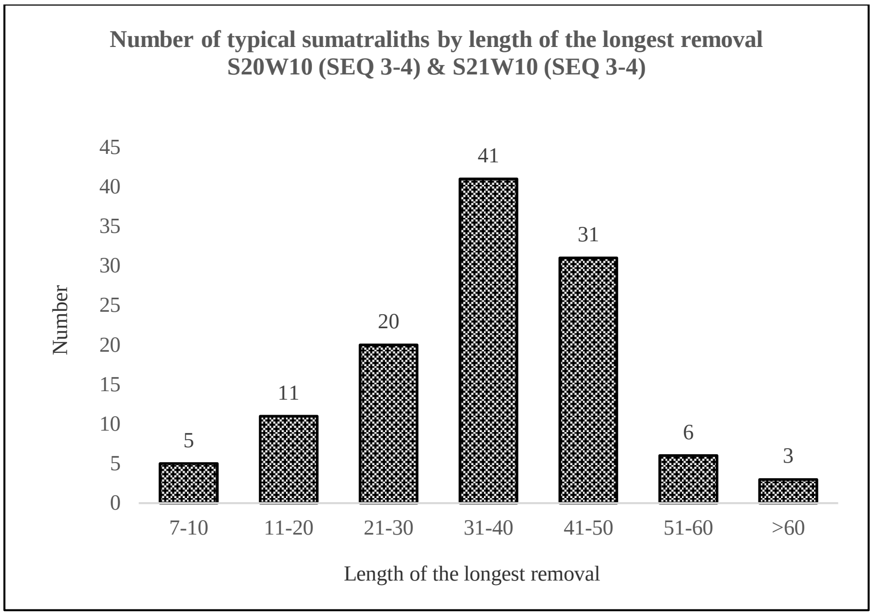


Figure 4.6.2.10 Distribution of length of the longest removal (in mm) on upper face of typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The length of the longest removal on the upper face of the typical sumatraliths varies from 7 to 84 mm, but it is intensified between 31 and 50 mm (62%: 73/117). The average ranges between 42 and 33 with exception of the layer 5 where the removals are exceptionally small (18 mm). These values are comparable to those of the choppers and scrapers together. It is to be noted that the very longest removals are in the layer 8 and the average maximal values are in the lower layers 8 to 9 **(Table 4.6.2.14, figure 4.6.2.10)**.

- *On the lower face*

Longest length **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**10-20**	**21-30**	**>60**	Total number of typical sumatraliths	Average maximal length
Layer 5 (400-470 cm dt.)	1	1	0	**2**	20
Layer 7 (520-580 cm dt.)	2	0	0	**2**	18
Layer 8 (580-620 cm dt.)	0	0	1	**1**	65
Layer 9 (620-700 cm dt.)	0	0	1	**1**	70
Total	**3**	**1**	**2**	**6**	

Table 4.6.2.15 Length of the longest removal on lower face of typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

On the lower face, the longest removal of the typical sumatraliths are quite short in the middle layers 5 and 7 (less than 20 mm) and much longer in the lower layers 8 and 9 (65-70 mm) (**Table 4.6.2.15**).

6) Morpho-functional features of typical sumatraliths: Nature of the edges

6.1) Nature of the lateral edges

Right side **S20W10 (SEQ 3-4) &** **S21W10 (SEQ 3-4)**	**Cortex & retouch**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Retouch Unifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**3**		**29**	78	**0**		**1**		**37**
Layer 4 (340-700 cm dt.)	**1**		**0**		**39**	95	**0**		**1**		**41**
Layer 5 (400-470 cm dt.)	**2**		**0**		**2**		**0**		**0**		**4**
Layer 6 (470- 520 cm dt.)	**1**		**3**		**6**	60	**0**		**0**		**10**
Layer 7 (520- 580 cm dt.)	**2**		**0**		**3**		**1**		**0**		**6**
Layer 8 (580-720 cm dt.)	**2**		**2**		**7**	64	**0**		**0**		**11**
Layer 9 (620-740 cm dt.)	**3**		**2**		**3**		**0**		**0**		**8**
Total	**15**	13	**10**	8	**89**	76	**1**		**2**		**117**

Left side **S20W10 (SEQ 3-4) &** **S21W10 (SEQ 3-4)**	**Cortex & Retouch**		**Fracture**		**Removal Unifacial**		**Retouch Unifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**1**		**3**		**32**	86	**1**		**37**
Layer 4 (340-700 cm dt.)	**0**		**1**		**38**	93	**2**		**41**
Layer 5 (400-470 cm dt.)	**0**		**1**		**3**		**0**		**4**
Layer 6 (470- 520 cm dt.)	**2**		**1**		**7**	70	**0**		**10**
Layer 7 (520- 580 cm dt.)	**2**		**2**		**2**		**0**		**6**
Layer 8 (580-720 cm dt.)	**2**		**2**		**7**	64	**0**		**11**
Layer 9 (620-740 cm dt.)	**2**		**2**		**4**		**0**		**8**
Total	**9**	8	**12**	10	**93**	79	**3**		**117**

Table 4.6.2.16 Nature of the lateral (right and left) edges of the typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The lateral edges of typical sumatraliths are mostly unifacially shaped (more than 75% in the whole sequence), but sometimes, they are cortical & retouched or they result from a fracture, intentional or not (nearly 20%). in a very few cases they are bifacially shaped or just retouched **(Table 4.6.2.16)**.

6.2) Nature of the distal edge

Distal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex & Retouch**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Retouch Unifacial**		**Pointed**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**0**		**1**		**35**	94	**0**		**1**		**0**		**37**
Layer 4 (340-700 cm dt.)	**1**		**1**		**39**	95	**0**		**0**		**0**		**41**
Layer 5 (400-470 cm dt.)	**0**		**0**		**3**		**1**		**0**		**0**		**4**
Layer 6 (470- 520 cm dt.)	**1**		**1**		**7**	70	**1**		**0**		**0**		**10**
Layer 7 (520- 580 cm dt.)	**0**		**1**		**5**	83	**0**		**0**		**0**		**6**
Layer 8 (580-720 cm dt.)	**0**		**1**		**9**	82	**0**		**0**		**1**		**11**
Layer 9 (620-740 cm dt.)	**0**		**0**		**8**	100	**0**		**0**		**0**		**8**
Total	**2**		**5**	4	**106**	90	**2**		**1**		**1**		**117**

Table 4.6.2.17 Nature of the distal edge of the typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Nearly all the distal edges of the typical sumatraliths are unifacially shaped (90%: 106/117). The other edges are bifacially shaped, retouched or fractured; a few are still cortical & retouched (**Table 4.6.2.17**).

6.3) Nature of the proximal edge

Proximal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex & Retouch**		**Fracture**		**Removal Unifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**1**		**5**	13	**31**	84	**37**
Layer 4 (340-700 cm dt.)	**1**		**4**		**36**	88	**41**
Layer 5 (400-470 cm dt.)	**0**		**1**		**3**		**4**
Layer 6 (470- 520 cm dt.)	**2**		**2**		**6**	60	**10**
Layer 7 (520- 580 cm dt.)	**2**		**4**		**0**		**6**
Layer 8 (580-720 cm dt.)	**5**	46	**3**		**3**		**11**
Layer 9 (620-740 cm dt.)	**1**		**1**		**6**	75	**8**
Total	**12**	10	**20**	17	**85**	73	**117**

Table 4.6.2.18 Nature of the proximal edge of the typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The proximal edge of typical sumatraliths is quite similar to the lateral edges, mostly unifacially shaped (73%: 85/117) but not only **(Table 4.6.2.18)**.

7) Morpho-functional features of typical sumatraliths: Angle of the edges

7.1) Angle of right and left edges

Right side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**14**	38	**14**	38	**8**	21	**1**		**37**
Layer 4 (340-700 cm dt.)	**20**	49	**11**	27	**9**	22	**1**		**41**
Layer 5 (400-470 cm dt.)	**2**		**2**		**0**		**0**		**4**
Layer 6 (470-520 cm dt.)	**3**		**2**		**3**		**2**		**10**
Layer 7 (520-580 cm dt.)	**3**		**2**		**0**		**1**		**6**
Layer 8 (580-720 cm dt.)	**1**		**3**		**3**		**4**		**11**
Layer 9 (620-740 cm dt.)	**0**		**0**		**5**	62	**3**		**8**
Total	**43**	37	**34**	29	**28**	24	**12**	10	**117**

Left side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	N	%	N	%	N	%	N	%	N
Layer 3 (320-640 cm dt.)	**14**	38	**13**	35	**9**	24	**1**		**37**
Layer 4 (340-700 cm dt.)	**16**	39	**18**	44	**6**	15	**1**		**41**
Layer 5 (400-470 cm dt.)	**3**		**1**		**0**		**0**		**4**
Layer 6 (470- 520 cm dt.)	**4**		**2**		**2**		**2**		**10**
Layer 7 (520- 580 cm dt.)	**2**		**2**		**1**		**1**		**6**
Layer 8 (580-720 cm dt.)	**3**		**4**		**3**		**1**		**11**
Layer 9 (620-740 cm dt.)	**1**		**1**		**1**		**5**	63	**8**
Total	**43**	37	**41**	35	**22**	19	**11**	9	**117**

Table 4.6.2.19 Angle of the right and left edges of the typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The lateral edges of the typical sumatraliths have the same shapes on both left and right sides. They are mostly acute or oblique (sharp to medium angled: nearly 70% globally), but in the lower layer 9 they are mainly steep or steep-inverse (open angled), and tend to be so in the layer 8 (**Table 4.6.2.19)**. Such steep morphology suggests apprehensive function rather than a cutting or any transformative function.

7.2) Angle of distal edge

Distal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**25**	68	**9**	24	**3**	8	**0**		**37**
Layer 4 (340-700 cm dt.)	**25**	61	**13**	32	**3**		**0**		**41**
Layer 5 (400-470 cm dt.)	**4**		**0**		**0**		**0**		**4**
Layer 6 (470- 520 cm dt.)	**5**	50	**1**		**3**		**1**		**10**
Layer 7 (520- 580 cm dt.)	**2**		**4**		**0**		**0**		**6**
Layer 8 (580-720 cm dt.)	**4**		**5**	46	**0**		**2**		**11**
Layer 9 (620-740 cm dt.)	**3**		**2**		**2**		**1**		**8**
Total	**68**	58	**34**	29	**11**	9	**4**		**117**

Table 4.6.2.20 Angle of distal edge of the typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The distal edge of the typical sumatraliths is rather sharper than the other edges with 58% (68/117) of acute angles and 29% (34/117) of oblique angles. The steep or steep-inverse edges also occur in distal position but they are less than 10% of the total (**Table 4.6.2.20**).

7.3) Angle of proximal edge

Proximal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**11**	30	**19**	51	**4**		**3**		**37**
Layer 4 (340-700 cm dt.)	**20**	49	**12**	29	**4**		**5**	12	**41**
Layer 5 (400-470 cm dt.)	**0**		**1**		**3**		**0**		**4**
Layer 6 (470- 520 cm dt.)	**5**	50	**1**		**1**		**3**		**10**
Layer 7 (520- 580 cm dt.)	**3**		**1**		**1**		**1**		**6**
Layer 8 (580-720 cm dt.)	**1**		**4**		**3**		**3**		**11**
Layer 9 (620-740 cm dt.)	**1**		**1**		**4**		**2**		**8**
Total	**41**	35	**39**	33	**20**	17	**17**	15	**117**

Table 4.6.1.21 Angle of proximal edge of the typical sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The proximal edges of the typical sumatraliths are somewhat identical to the lateral edges; most of them are acute or oblique (sharp or medium angled: nearly 70%). Steep or steep-inverse are overall as frequent as on the lateral sides, around 16% each, but more common in the lower layers 8 and 9, as for the lateral steep edges **(Table 4.6.1.21)**

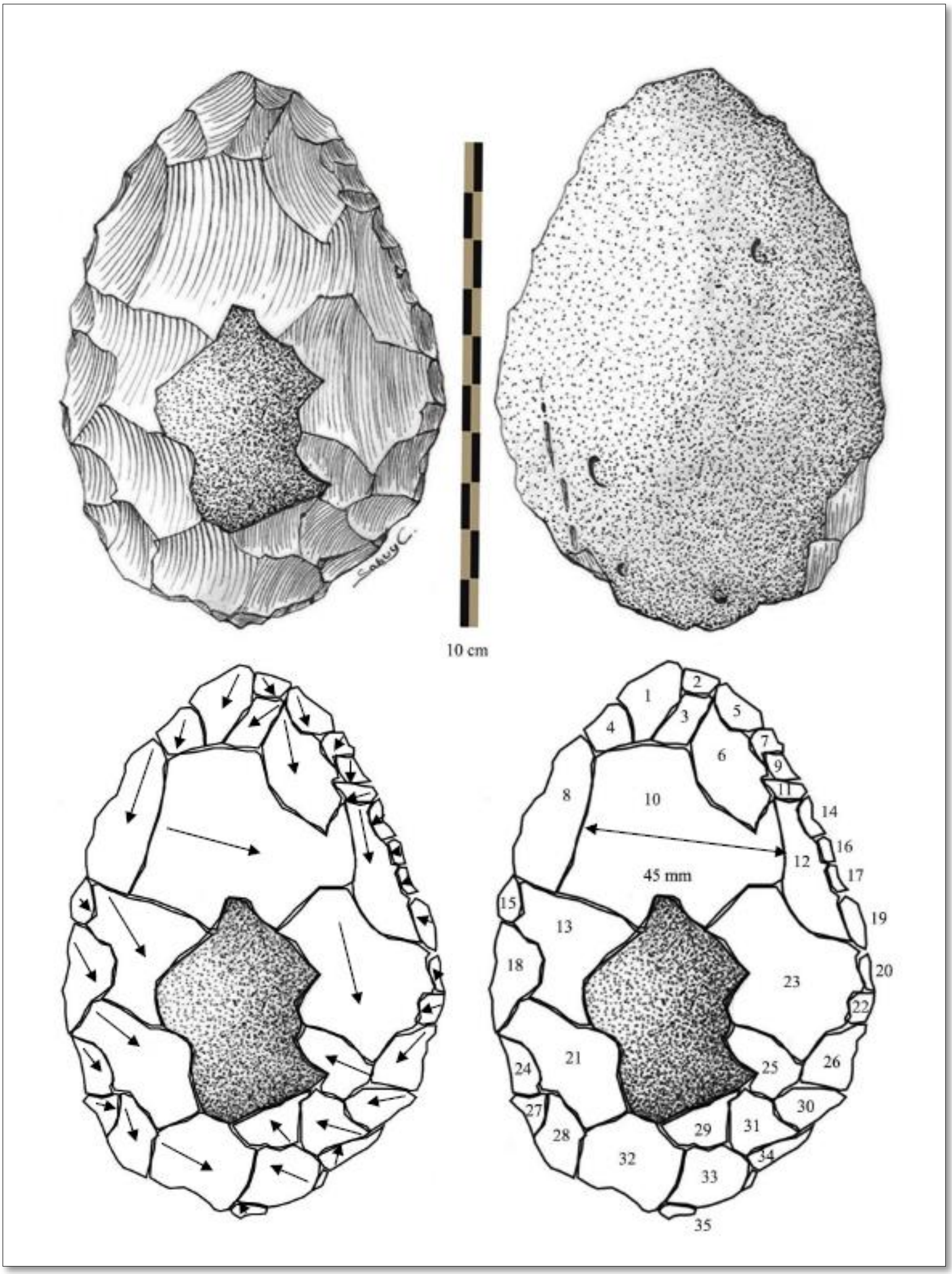


Figure 4.6.2.11 Main form of typical sumatralith found at Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4); illustrating the direction and number of removals and retouches (< 5 mm; drawings T. Chitkament)

4.6.3 Partial sumatraliths (large & small tools)

The partial sumatraliths are not shaped all around and, thus, are not typical, but their overall or half shapes are rather closed to those of the typical sumatraliths; they will be called “partial sumatralith” (sumatralith partly shaped), a few of them being bifacially shaped. They are comprised of several main groups of tools: 1/2 sumatraliths, 1/4 sumatraliths, 3/4 sumatraliths, partly unifacial, partly bifacial and unifacial discoid. All these tools will be considered together regardless their classification as large or small tool (longer or shorter than 10 cm) just like the typical sumatraliths.

1) General features of the partial sumatraliths

Around 16% (131/794) of all the tools (large and small) in the stratigraphic layers 3 to 10 of area 2, sector S20W10 and S21W10 are partial sumatraliths. The layer 6 is remarkable in the sequence: 29% (13/45), followed by the layer 3 (21%; 57/226). In the other layers their frequency is below 20% with regard to all the tools. No partial sumatraliths are present in the bottom layer 10 as in the case of the typical sumatraliths **(Tables 4.2.2, 4.6.2.1)**.

Partial sumatraliths **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Layer 3**		**Layer 4**		**Layer 5**		**Layer 6**		**Layer 7**		**Layer 8**		**Layer 9**		**Layer 10**		**Total**
Numbers (%)	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
S20W10 (SEQ 3-4)	**53**	53	**32**	32							**3**		**1**				**89**
S21W10 (SEQ 3-4)	**4**		**2**		**3**		**13**	31	**7**	17	**4**		**9**	21			**42**
S21W10 (SEQ 1-2)	**-**		**-**		**2**		**16**	76	**3**		**-**		**-**		**-**		**20**
S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**57**	21	**34**	17	**3**		**13**	29	**7**	11	**7**	7	**10**	13			**131**(16%)
All tools (large & small) S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**226**		**200**		**21**		**45**		**66**		**103**		**75**		**18**		**794**

Table 4.6.3.1 Distribution of partial sumatraliths in the stratigraphic sequence of Tham Lod Rockshelter and in the different studied sectors of area 2: sectors S20W10 (SEQ 3-4) and S21W10 (SEQ 3-4) as well as sector S21W10 (SEQ 1-2) for layers 7 to 5 only (which are missing in S20W10 as they correspond to a rock fall only occurring towards the shelter wall).

Partial sumatraliths **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**3/4 Sumatra-lith**		**1/2 Sumatra-lith**		**1/4 Sumatra-lith**		**Partly unifacial Sumatra-lith**		**Partly bifacial Sumatra -lith**		**1/2 bifacial Sumatra-lith**		**Unifacial discoid**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**11**	19	**21**	37	**4**		**12**	21	**5**	9	**2**		**2**		**57**
Layer 4 (340-700 cm dt.)	**8**	23	**11**	32	**6**	18	**2**		**3**		**2**		**2**		**34**
Layer 5 (400-470 cm dt.)	**1**		**0**		**2**		**0**		**0**		**0**		**0**		**3**
Layer 6 (470-520 cm dt.)	**3**		**8**	61	**1**		**0**		**1**		**0**		**0**		**13**
Layer 7 (520-580 cm dt.)	**2**		**4**		**1**		**0**		**0**		**0**		**0**		**7**
Layer 8 (580-720 cm dt.)	**1**		**4**		**0**		**1**		**1**		**0**		**0**		**7**
Layer 9 (620-740 cm dt.)	**3**		**5**		**1**		**0**		**0**		**0**		**1**		**10**
Total	**29**	22	**53**	41	**15**	11	**15**	11	**10**	8	**4**		**5**	4	**131**

Table 4.6.3.2 Distribution of partial sumatraliths in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) and S21W10 (SEQ 3-4)

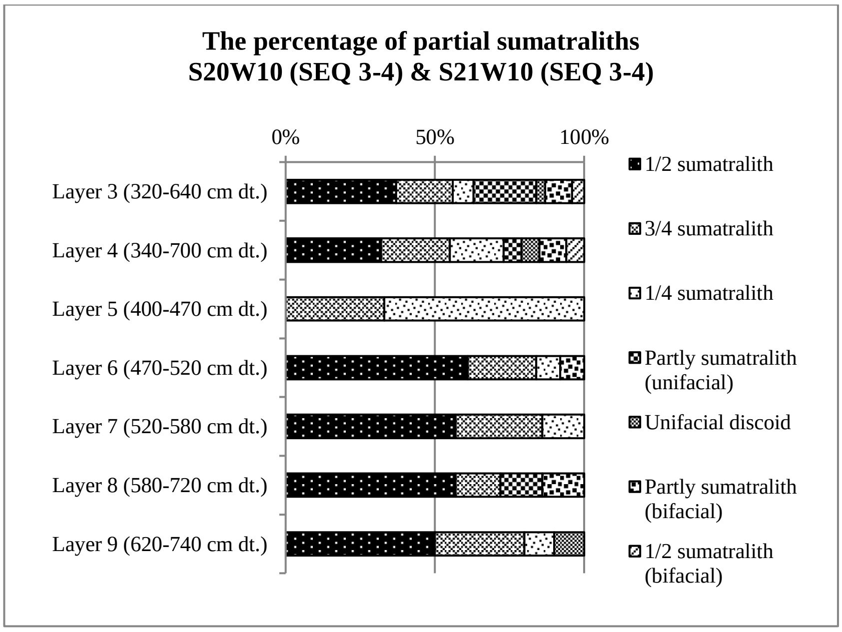


Figure 4.6.3.1 Distribution of partial sumatraliths in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) and S21W10 (SEQ 3-4)

Raw materials **S20W10 (SEQ 3-4)** **S21W10 (SEQ 3-4)**	**Gray sandstone**		**Black sandstone**		**Quartzite**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**54**	95	**2**		**1**		**57**
Layer 4 (340-700 cm dt.)	**34**	100	**0**		**0**		**34**
Layer 5 (400-470 cm dt.)	**3**		**0**		**0**		**3**
Layer 6 (470-520 cm dt.)	**12**	92	**1**		**0**		**13**
Layer 7 (520-580 cm dt.)	**7**	100	**0**		**0**		**7**
Layer 8 (580-720 cm dt.)	**7**	100	**0**		**0**		**7**
Layer 9 (620-740 cm dt.)	**9**	90	**1**		**0**		**10**
Total	**126**	96	**4**	4/131	**1**		**131**

Table 4.6.3.3 The raw materials of partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Almost all the partial sumatraliths are made in gray sandstone (96%: 126/131), similarly to the typical sumatraliths, along with the choppers and scrapers. A few specimens in black sandstone are present in the layers 3, 6 and 9, and one in quartzite in the layer 3 **(Table 4.6.3.3)**.

2) Measurements

Stratigraphic layers	**Length (mm)**	**Width (mm)**	**Thickness (mm)**	**Number of partial sumatraliths**
Layer 3 (320-640 cm dt.)	97	68	40	57
Layer 4 (340-700 cm dt.)	91	66	32	34
Layer 5 (400-470 cm dt.)	108	44	33	3
Layer 6 (470-520 cm dt.)	79	64	29	13
Layer 7 (520-580 cm dt.)	90	62	42	7
Layer 8 (580-720 cm dt.)	94	80	39	7
Layer 9 (620-740 cm dt.)	101	73	50	10
Average	**94**	**67**	**38**	**131**

Table 4.6.3.4 Average dimensions of the partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The average measurements of the partial sumatraliths are quite smaller than those of the typical sumatraliths (114 mm, 72 mm and 41 mm. The longest partial sumatraliths are in the layer 5 (108 mm, but for 3 specimens only), and the shortest are in the layer 6 (79 mm), but in the other layers, the length is quite constant (90-101 mm). The narrowest are in the layer 5 (44 mm, with only 3 specimens). The average thickness is around 38 mm, but most of the values are between 29 and 42 mm, with the exception of the lower layer 9, with about 50 mm **(Table 4.6.3.4, figures 4.6.3.5 & 4.6.3.6)**.

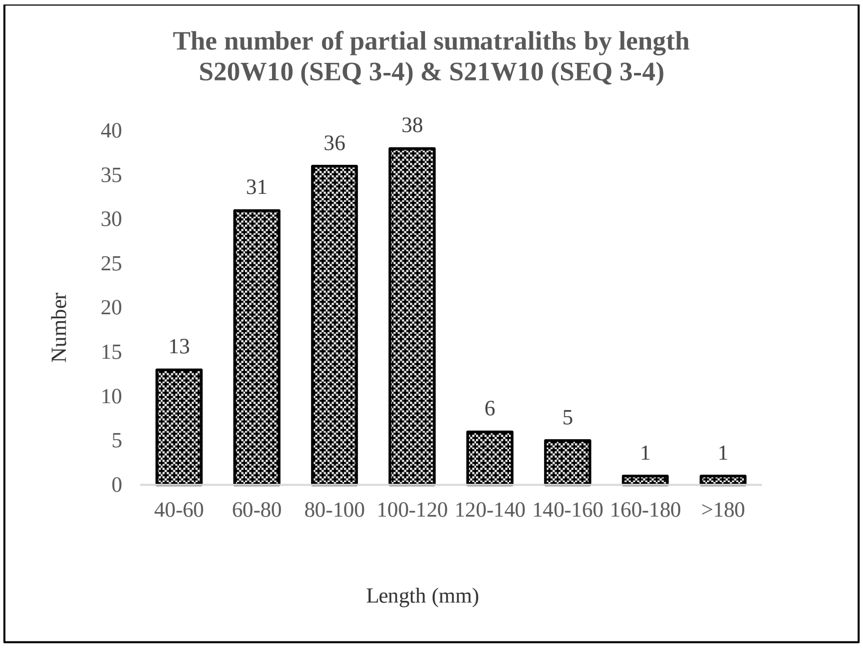


Figure 4.6.3.2 Distribution of the length of partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

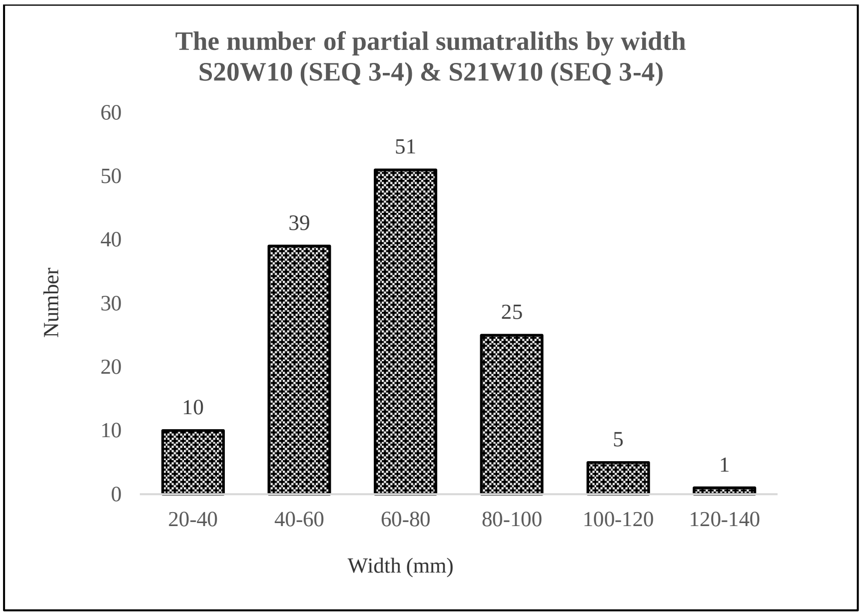


Figure 4.6.3.3 Distribution of the width of partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

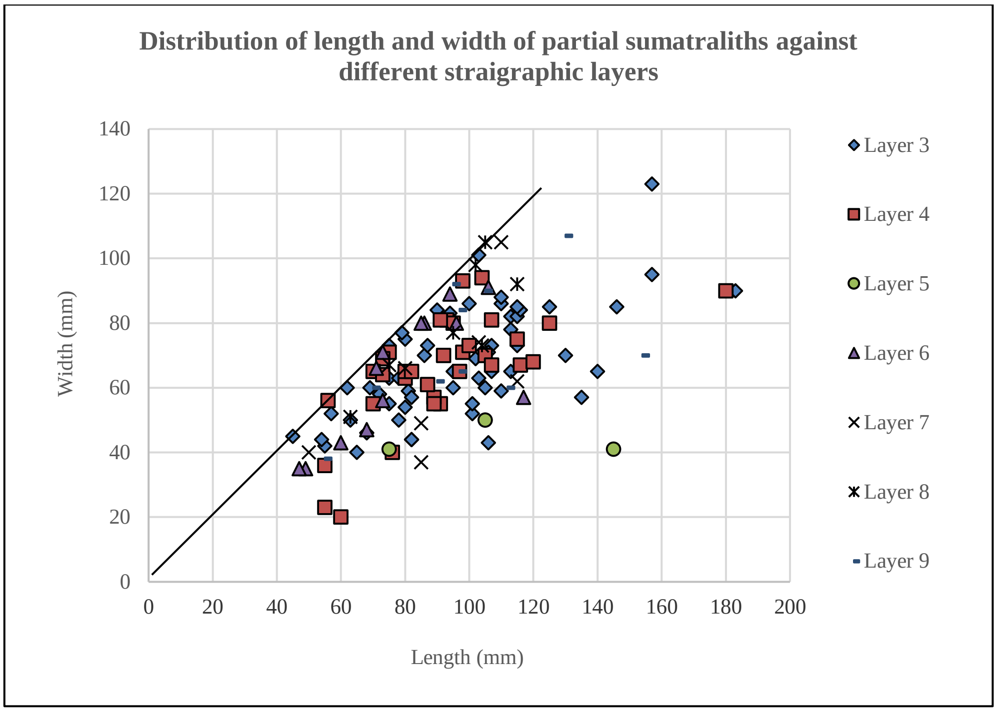


Figure 4.6.3.4 Scatter diagram of length x width of the partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The distribution of length and width of the partial sumatraliths are unimodal, indicating that this group of tools is homogenous **(figures 4.6.3.3 and 4.6.3.4)**. This homogeneity is confirmed by the scatter diagram of width against length (**figure 4.6.3.4**). However, the distribution of the length is more developed towards the small values and stops almost suddenly after 120 mm. The same feature can be observed for the typical sumatraliths, but with a break around 140 mm. Large specimens are not in the template of these tool types, unlike the choppers for instance.

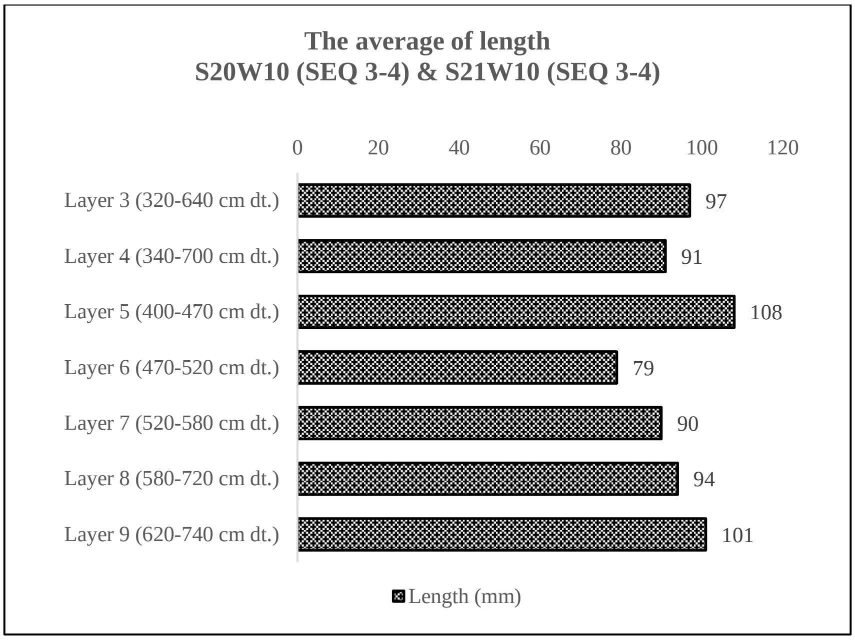


Figure 4.6.3.5 Distribution of the average length of the partial sumatraliths across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

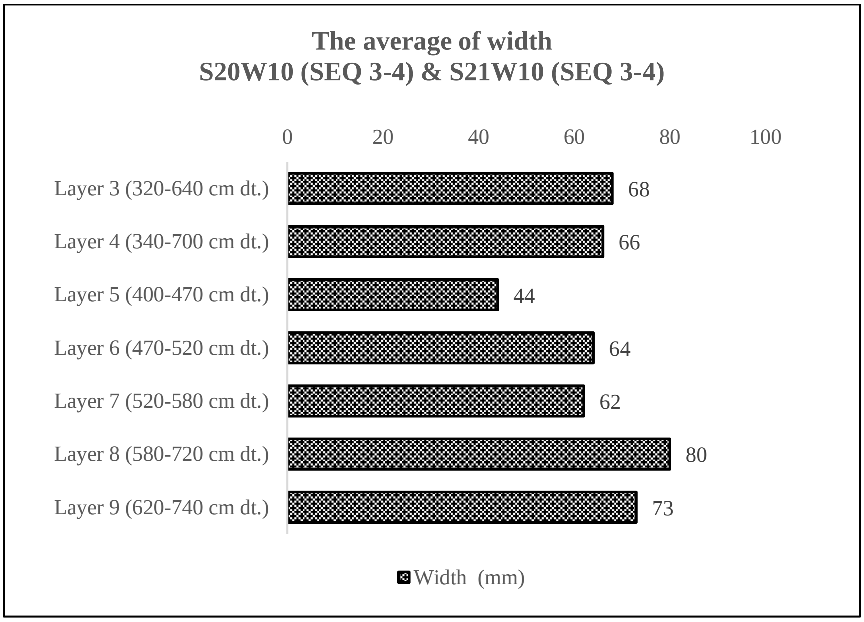


Figure 4.6.3.6 Distribution of the average width of the partial sumatraliths across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Weight (gr.) **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**<200**	**201-400**	**401-600**	**601-800**	**801-1000**	**1001-1200**	**1201-1400**	**>1400**	**Total**
Layer 3 (320-340 cm dt.)	17	19	13	5	1	0	1	1	**57**
Layer 4 (340-400 cm dt.)	11	16	6	1	0	0	0	0	**34**
Layer 5 (400-470 cm dt.)	2	0	1	0	0	0	0	0	**3**
Layer 6 (470-520 cm dt.)	7	4	0	1	0		1	0	**13**
Layer 7 (520-580 cm dt.)	3	2	0	1	1	0	0	0	**7**
Layer 8 (580-620 cm dt.)	1	2	3	1	0	0	0	0	**7**
Layer 9 (620-700 cm dt.)	3	3	3	1	0	0	0	0	**10**
Total	**44**	**46**	**26**	**10**	**2**	**0**	**2**	**1**	**131**

Table 4.6.3.5 The weight (in gram) of partial sumatraliths from Tham Lod Rockshelter, are 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

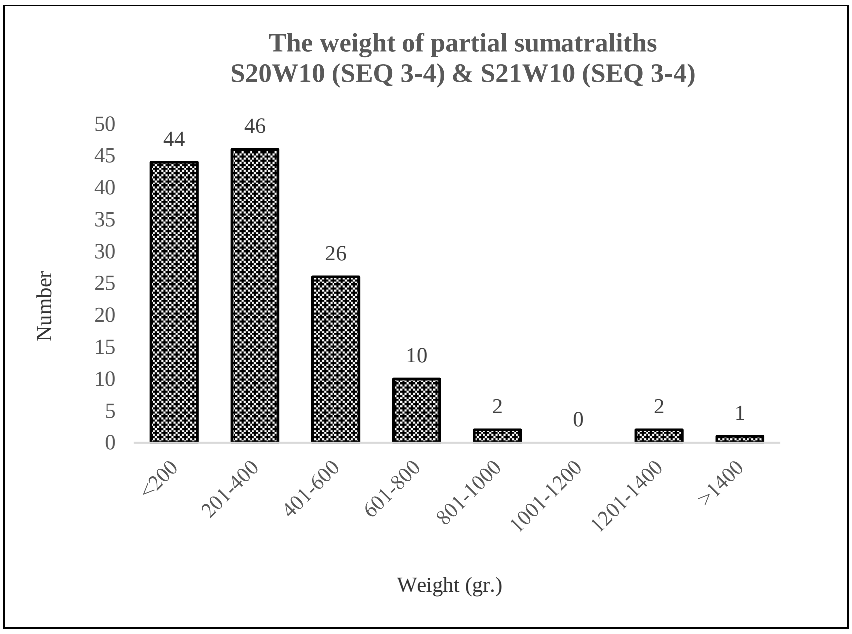


Figure 4.6.3.7 Distribution of the weight (in gram) of partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The weight classes of partial sumatraliths are identical to those of the typical sumatraliths, both weighing usually less than 600 g; the range between less than 200 and 400 g is especially wealthy for the partial sumatraliths (90 tools: 70% of the total number; **Table 4.6.2.5, figure 4.6.2.7**).

3) Supports

The large majority of supports are broken cobbles (67%; 88/131) or broken pebbles (< 6 cm; 10%; 13/131), and this is observed in all the layers in similar proportions, with exception of the layer 8, where it seems lower (3/7). The whole cobbles are hardly more than 10% and the split cobbles almost absent as supports. The other supports are cobble fragments (of which the original shape of the cobble cannot be assessed; **Table 4.6.2.6, figure 4.6.2.8**).

Supports **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Broken cobble**		**Cobble fragment**		**Whole cobble**		**Split cobble**		**Indeter-minate cobble**		**Broken pebble**		**Flake**		**Fragment**		**Total**
Layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3	**39**	68	**1**		**7**	12	**2**		**0**		**6**	11	**0**		**2**		**57**
Layer 4	**23**	67	**3**		**5**	15	**0**		**1**		**2**		**0**		**0**		**34**
Layer 5	**2**		**1**		**0**		**0**		**0**		**0**		**0**		**0**		**3**
Layer 6	**9**	69	**1**		**0**		**0**		**0**		**2**		**1**		**0**		**13**
Layer 7	**5**	72	**1**		**0**		**0**		**0**		**1**		**0**		**0**		**7**
Layer 8	**3**		**2**		**1**		**0**		**0**		**1**		**0**		**0**		**7**
Layer 9	**7**	70	**1**		**1**		**0**		**0**		**1**		**0**		**0**		**10**
Total	**88**	67	**10**	8	**14**	11	**2**		**1**		**13**	10	**1**		**2**		**131**

Table 4.6.3.6 The supports of partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

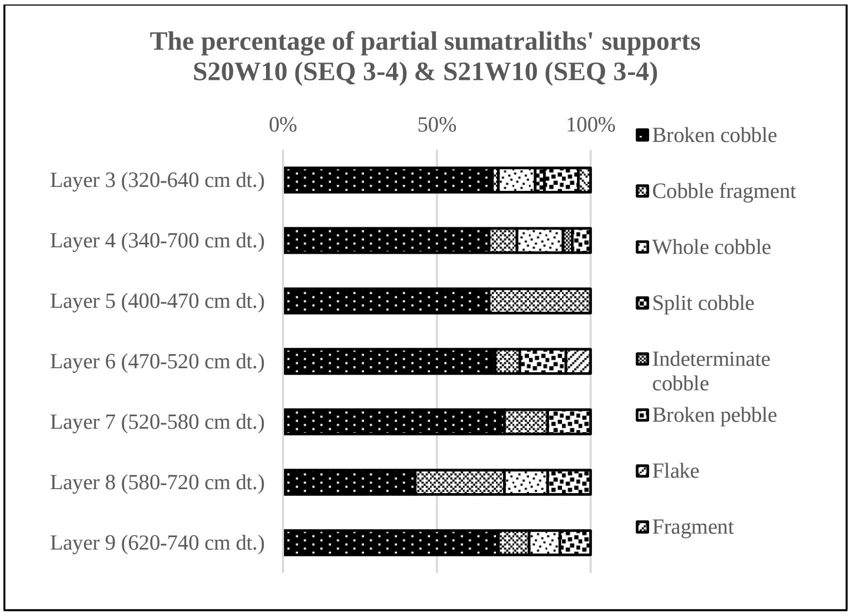


Figure 4.6.3.8 Distribution of the supports of partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4) General morphology of partial sumatraliths

4.1) Frontal view

Frontal view S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Half-oval**		**Oval**		**Irre-gular**		**D-shape**		**Trian-gular**		**Circular**		**Trape-zoidal**		**Penta-gonal**		**Almond**		**Bi-convex**		**Convex-concave**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**27**	48	**12**	21	**5**	9	**3**		**6**	10	**1**		**2**		**0**		**1**		**0**		**0**		**57**
Layer 4 (340-700 cm dt.)	**17**	49	**5**	15	**2**		**3**		**1**		**2**		**2**		**0**		**0**		**1**		**1**		**34**
Layer 5 (400-470 cm dt.)	**0**		**0**		**2**		**1**		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**3**
Layer 6 (470-520 cm dt.)	**10**	77	**0**		**2**		**0**		**0**		**1**		**0**		**0**		**0**		**0**		**0**		**13**
Layer 7 (520-580 cm dt.)	**3**		**0**		**0**		**0**		**0**		**2**		**2**		**0**		**0**		**0**		**0**		**7**
Layer 8 (580-720 cm dt.)	**3**		**4**		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**7**
Layer 9 (620-740 cm dt.)	**3**		**0**		**2**		**1**		**1**		**1**		**1**		**1**		**0**		**0**		**0**		**10**
Total	**63**	48	**21**	16	**13**	10	**8**	6	**8**	6	**7**	5	**7**	5	**1**		**1**		**1**		**1**		**131**

Table 4.6.3.7 The frontal view of partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4.2) Transversal view

Transversal view S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Oval**		**Triangular**		**Trape-zoidal**		**Irregular**		**D-shape**		**Penta-gonal**		**Half-oval**		**Almond**		**Bi-convex**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**15**	26	**14**	25	**10**	18	**7**	12	**5**	9	**2**		**1**		**2**		**1**		**57**
Layer 4 (340-700 cm dt.)	**10**	29	**5**	15	**8**	23	**4**		**4**		**2**		**1**		**0**		**0**		**34**
Layer 5 (400-470 cm dt.)	**1**		**0**		**2**		**0**		**0**		**0**		**0**		**0**		**0**		**3**
Layer 6 (470-520 cm dt.)	**4**		**4**		**1**		**2**		**1**		**1**		**0**		**0**		**0**		**13**
Layer 7 (520-580 cm dt.)	**3**		**0**		**0**		**2**		**0**		**0**		**2**		**0**		**0**		**7**
Layer 8 (580-720 cm dt.)	**3**		**3**		**1**		**0**		**0**		**0**		**0**		**0**		**0**		**7**
Layer 9 (620-740 cm dt.)	**1**		**3**		**2**		**3**		**1**		**0**		**0**		**0**		**0**		**10**
Total	**37**	28	**29**	22	**24**	19	**18**	14	**11**	8	**5**	4	**4**	4/131	**2**		**1**		**131**

Table 4.6.3.8 The transversal view of partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The half-oval shape of the partial sumatraliths is remarkable in the frontal view, representing 48% (63/131) unlike the typical sumatraliths, which mostly have an oval shape. The highest proportion is in layer 6 (77%: 10/13). In the other layers, this shape frequently grades between 60-30%. The other shapes are rather infrequent, except for the oval shape, which is noticeable in the layer 8, with 3/7 **(Table 4.6.2.7)**.

In the transversal view, the shapes are quite different from the other tools, as they are mostly oval 28% (37/131) especially in the layers 7 and 8 (43%). Then, the triangular shape also occurs often (22%: 29/131) and is conspicuous in the layer 8 (43%), but it is quite variable among the layers **(Table 4.6.3.8)**.

5) Shaping of the partial sumatraliths

5.1) Amount of cortex

- On the upper face

Amount of cortex **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**11**	19	**24**	42	**22**	39	**57**
Layer 4 (340-700 cm dt.)	**6**	18	**17**	50	**11**	32	**34**
Layer 5 (400-470 cm dt.)	**1**		**1**		**1**		**3**
Layer 6 (470-520 cm dt.)	**3**		**5**	38	**5**	39	**13**
Layer 7 (520-580 cm dt.)	**4**		**2**		**1**		**7**
Layer 8 (580-720 cm dt.)	**1**		**4**		**2**		**7**
Layer 9 (620-740 cm dt.)	**4**		**1**		**5**	50	**10**
Total	**30**	23	**54**	41	**47**	36	**131**

Table 4.6.3.9 Amount of cortex on upper face of the partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The upper face of partial sumatraliths is mostly “non-cortical dominant” (41%: 54/131) or “non-cortical” (36%: 47/36), almost like the typical sumatraliths. Non-cortical dominant” specimens are remarkable in the layer 8 (4/7) then the “non-cortical” in the layer 9 (50%: 5/10). The “cortical dominant” only represents 23% (30/131; **Table 4.6.3.9, figure 4.6.3.9)**.

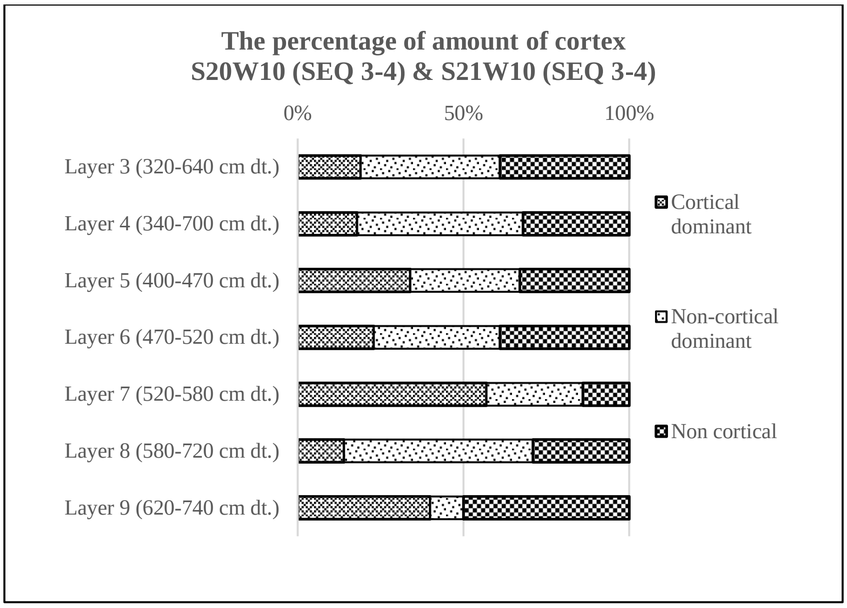


Figure 4.6.3.9 Distribution of the amount of cortex on the upper face of partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

- *On the lower face*

Amount of cortex **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Totally cortical**		**Cortical dominant** (>50% cortical)		**Non-cortical dominant** (<50% cortical)		**Non cortical**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**35**	61	**15**	26	**5**		**2**		**57**
Layer 4 (340-700 cm dt.)	**26**	76	**8**	24	**0**		**0**		**37**
Layer 5 (400-470 cm dt.)	**1**		**0**		**1**		**1**		**3**
Layer 6 (470-520 cm dt.)	**6**	46	**4**		**3**		**0**		**13**
Layer 7 (520-580 cm dt.)	**4**		**2**		**0**		**1**		**7**
Layer 8 (580-720 cm dt.)	**5**	72	**1**		**1**		**0**		**7**
Layer 9 (620-740 cm dt.)	**6**	60	**2**		**2**		**0**		**10**
Total	**83**	63	**32**	25	**12**	9	**4**		**131**

Table 4.6.3.10 Amount of cortex on lower face of the partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

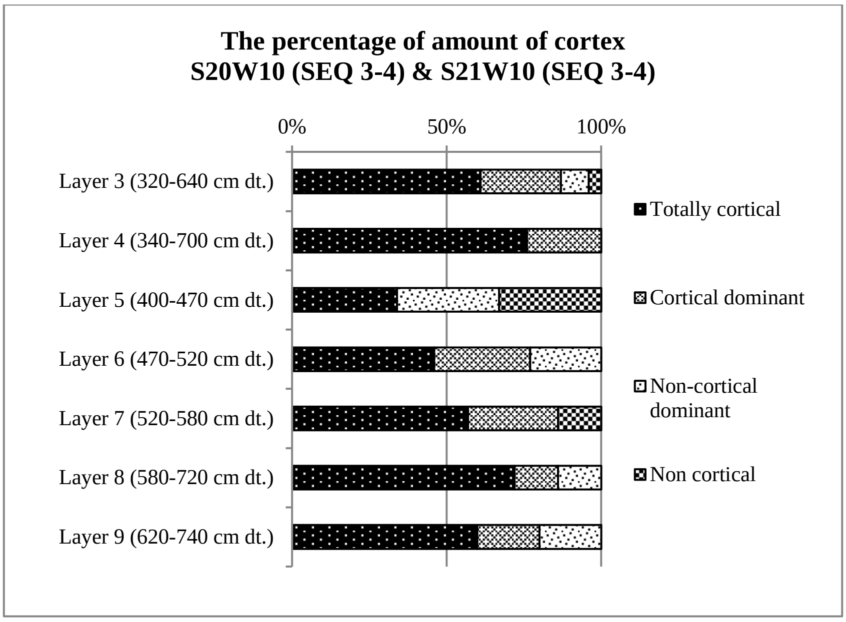


Figure 4.6.3.10 Distribution of the amount of cortex on the lower face of partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Around 63% (83/131) of partial sumatraliths are “totally cortical” on the lower face; these are overwhelmingly found in the layer 4 (76%: 26/34) and the least in the layer 5 (only 1 specimen). For the other specimens, the lower face is more commonly “cortical dominant”, with about 25% (32/131), followed by the “non-cortical dominant” and “non-cortical” **(Table 4.6.3.10, figure 4.6.3.10)**.

5.2) Number of removals (shaping the tools)

- On the upper face

Number of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**>10 (~15)**	Total number of partial sumatraliths	Total number of removals	Average number of removals (total number of removals / total number of all tools)
Layer 3	0	0	2	4	2	4	9	6	3	27	**57**	**629**	11,0
Layer 4	0	0	0	1	0	4	1	2	2	24	**34**	**439**	12,9
Layer 5	1	0	0	1	0	0	0	0	0	1	**3**	**22**	7,3
Layer 6	0	0	0	0	1	2	0	2	0	8	**13**	**158**	12,2
Layer 7	0	0	0	2	0	0	2	0	0	3	**7**	**71**	10,1
Layer 8	0	2	1	1	1	0	0	2	0	0	**7**	**51**	7,3
Layer 9	1	0	2	0	0	2	1	0	0	4	**10**	**116**	11,6
Total	**2**	**2**	**5**	**9**	**4**	**12**	**13**	**12**	**5**	**67**	**131**	**1486**	11,3

Table 4.6.3.11 Number of removals on upper face of the partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Approximately half of the partial sumatraliths have more than 10 removals: 51% (67/131), but in the layer 4 such better shaped tools represent more than two third (24/34: 70%). The average number of removals is between 10 and 13, except in the layers 5 and 8, where it is around 7.3 **(Table 4.6.3.11)**.

- On the lower face

Number of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**1**	**2**	**3**	**4**	**5**	**7**	**8**	Total number of partial sumatraliths with removals on the lower face	Total number of removals	Average number of removals (total number of removals / total number of all tools)
Layer 3 (320-640 cm dt.)	1	3	0	2	0	0	2	**8**	**31**	3,9
Layer 4 (340-700 cm dt.)	0	0	2	1	2	0	0	**5**	**16**	3,2
Layer 6 (470-520 cm dt.)	2	0	0	0	0	1	0	**3**	**9**	3,0
Layer 8 (580-720 cm dt.)	0	1	1	0	0	0	0	**2**	**5**	2,5
Layer 9 (620-740 cm dt.)	0	0	1	0	0	0	0	**1**	**3**	3,0
Total	**3**	**4**	**4**	**3**	**2**	**1**	**2**	**19**	**64**	3,4

Table 4.6.3.12 Number of removals on lower face of the partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The partial sumatraliths shaped on the lower face are representing 15% (19/131) of the total, and they display not more than 8 removals **(Tables 4.6.2.12)**.

5.3) Direction of removals

- On the upper face

Direction of removals **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Unipolar**		**Bipolar-opposite**		**Bidirectional-orthogonal**		**Three-directions**		**Convergent**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**7**	12	**4**		**7**	12	**16**	28	**23**	41	**57**
Layer 4 (340-700 cm dt.)	**1**		**0**		**6**	18	**18**	53	**9**	26	**34**
Layer 5 (400-470 cm dt.)	**2**		**0**		**0**		**1**		**0**		**3**
Layer 6 (470-520 cm dt.)	**1**		**0**		**1**		**10**	77	**1**		**13**
Layer 7 (520-580 cm dt.)	**2**		**0**		**0**		**5**	71	**0**		**7**
Layer 8 (580-720 cm dt.)	**1**		**2**		**0**		**4**		**0**		**7**
Layer 9 (620-740 cm dt.)	**3**		**1**		**1**		**4**		**1**		**10**
Total	**17**	13	**7**	5	**15**	12	**58**	44	**34**	26	**131**

Table 4.6.3.13 Direction of removals on upper face of the partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

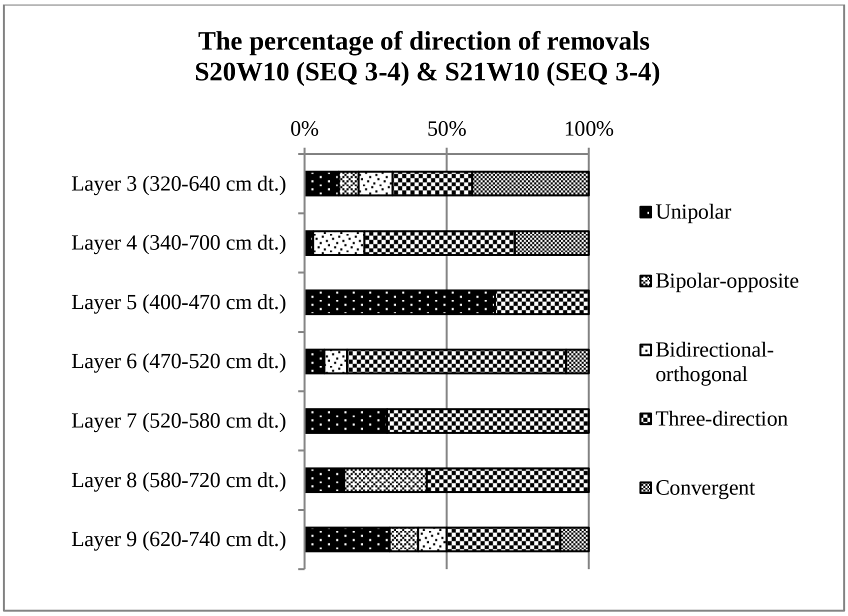


Figure 4.6.3.11 Distribution of the direction of removals on the upper face of the partial sumatraliths from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The upper removals of partial sumatraliths are preponderantly in the “three-directions” pattern, with about 44% (58/131), especially in the middle layers, mainly in the layer 6 (10/13: 77%); the proportion is the lowest in layer 3 (16/57: 28%). Thereafter, the “convergent” pattern is representing 26% (34/131) but it is particularly frequent in the layer 3 (23/57: 41%). The other patterns such as “bipolar-opposite” and “bidirectional-orthogonal” are rare and correspond to the partial sumatraliths on shaped on one or two edges **(Table 4.6.3.13)**.

- *On the lower face*

Direction of removals S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Unipolar**		**Bipolar-opposite**		**Three-directions**		**Convergent**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**5**	62	**2**		**1**		**0**		**8**
Layer 4 (340-700 cm dt.)	**3**		**0**		**1**		**1**		**5**
Layer 6 (470-520 cm dt.)	**2**		**0**		**0**		**1**		**3**
Layer 8 (580-720 cm dt.)	**1**		**0**		**1**		**0**		**2**
Layer 9 (620-740 cm dt.)	**0**		**1**		**0**		**0**		**1**
Total	**11**	58	**3**		**3**		**2**		**19**

Table 4.6.3.14 Direction of removals on upper face of the partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

On the lower face the majority of removals are unipolar unidirectional: 58% (11/19), in accordance with their very small number. The other patterns like "bipolar-opposite", "three-directions" and "convergent" are much less (around 15% each) and mostly correspond to the few bifacial specimens. **(Table 4.6.2.14)**.

4.4) Length of the longest removal

- On the upper face

Longest removal S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**10-20**	**21-30**	**31-40**	**41-50**	**51-60**	**61-70**	Total number of partial sumatraliths	Average maximal length (mm)
Layer 3 (320-640 cm dt.)	6	17	21	11	1	1	**57**	33
Layer 4 (340-700 cm dt.)	6	10	11	5	2	0	**34**	32
Layer 5 (400-470 cm dt.)	0	1	1	0	1	0	**3**	38
Layer 6 (470-520 cm dt.)	3	4	2	2	2	0	**13**	33
Layer 7 (520-580 cm dt.)	2	2	2	1	0	0	**7**	30
Layer 8 (580-720 cm dt.)	3	1	2	1	0	0	**7**	27
Layer 9 (620-740 cm dt.)	3	2	3	1	1	0	**10**	30
Total	**23**	**37**	**42**	**21**	**7**	**1**	**131**	

Table 4.6.3.15 Length of the longest removal (in mm) on upper face of partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The length of longest removal of partial sumatraliths is ranging from 10 mm to 70 mm and it follows a normal (unimodal, symmetrical) distribution with a maximal frequency between 31 and 40 mm (42 tools: 32%). The average length may be slightly smaller in the lower layers 9 to 7 (27 to 30 mm) than in the overlying layers (32 to 38 m; **Table 4.6.3.15, figure 4.6.3.12**).

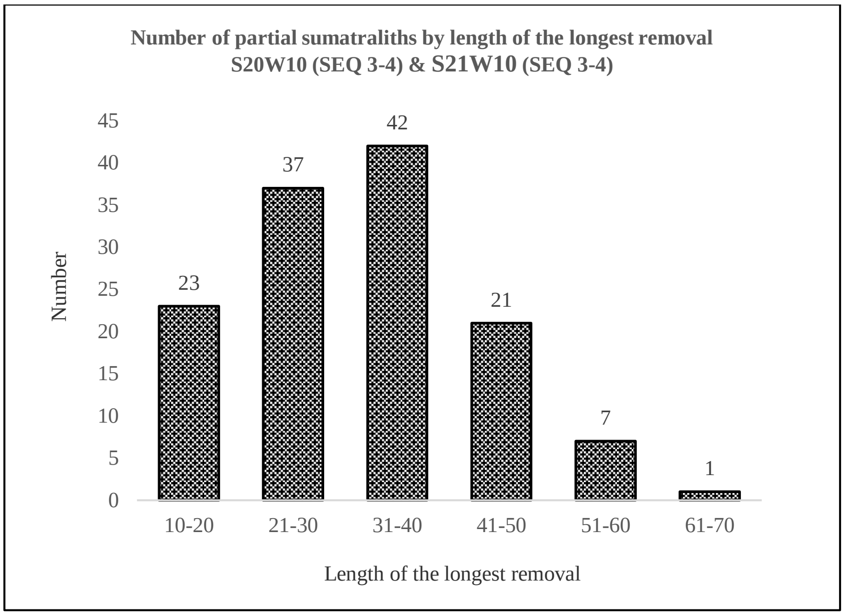


Figure 4.6.3.12 Distribution of length of the longest removal (in mm) on upper face of partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

- *On the lower face*

Longest lengths **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**10-20**	**21-30**	**31-40**	**41-50**	**51-60**	Total number of partial sumatraliths	Average maximal length
Layer 3 (320-640 cm dt.)	3	1	2	1	1	**8**	32
Layer 4 (340-700 cm dt.)	1	2	0	2	0	**5**	32
Layer 6 (470-520 cm dt.)	1	2	0	1	0	**4**	24
Layer 8 (580-720 cm dt.)	1	0	0	0	0	**1**	28
Layer 9 (620-740 cm dt.)	0	0	0	0	1	**1**	57
Total	**6**	**5**	**2**	**4**	**2**	19	

Table 4.6.3.16 Length of the longest removals on lower face of partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

On the lower face, the average length of the longest removals is slightly smaller than on the upper face. The values are concentrated between 10 and 30 mm and do not go beyond 60 mm **(Table 4.6.3.16)**.

6) Morpho-functional features of typical sumatraliths: Nature of the edges

6.1) Nature of the lateral edges

Right side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Retouch Unifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**5**	9	**3**		**47**	82	**1**		**1**		**57**
Layer 4 (340-700 cm dt.)	**2**		**2**		**27**	79	**2**		**1**		**34**
Layer 5 (400-470 cm dt.)	**0**		**1**		**2**		**0**		**0**		**3**
Layer 6 (470-520 cm dt.)	**0**		**0**		**12**	92	**1**		**0**		**13**
Layer 7 (520-580 cm dt.)	**2**		**1**		**4**		**0**		**0**		**7**
Layer 8 (580-720 cm dt.)	**1**		**1**		**5**	72	**0**		**0**		**7**
Layer 9 (620-740 cm dt.)	**1**		**1**		**8**	80	**0**		**0**		**10**
Total	**11**	8	**9**	7	**105**	80	**4**		**2**		**131**

Left side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Retouch Unifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**8**	14	**2**		**47**	82	**0**		**0**		**57**
Layer 4 (340-700 cm dt.)	**1**		**3**		**27**	79	**2**		**1**		**34**
Layer 5 (400-470 cm dt.)	**0**		**1**		**2**		**0**		**0**		**3**
Layer 6 (470-520 cm dt.)	**1**		**1**		**10**	77	**1**		**0**		**13**
Layer 7 (520-580 cm dt.)	**0**		**1**		**6**	86	**0**		**0**		**7**
Layer 8 (580-720 cm dt.)	**2**		**1**		**3**		**1**		**0**		**7**
Layer 9 (620-740 cm dt.)	**2**		**0**		**8**	80	**0**		**0**		**10**
Total	**14**	11	**9**	7	**103**	78	**4**		**1**		**131**

Table 4.6.3.17 Nature of the lateral (right and left) edges of the partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Lateral edges of the partial sumatraliths are shaped in most of the cases (nearly 85%), almost always unifacially, and with equal frequency on right and left sides. The other lateral sides are cortical or made of a fracture: less than 15% of the studied material (**Table 4.6.3.17**). this frequency of shaping on lateral edges is comparable to that of the typical sumatraliths.

6.2) Nature of the distal edge

Distal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Retouch Unifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**2**		**6**	11	**46**	81	**2**		**1**		**57**
Layer 4 (340-700 cm dt.)	**0**		**1**		**29**	85	**3**		**1**		**34**
Layer 5 (400-470 cm dt.)	**0**		**1**		**2**		**0**		**0**		**3**
Layer 6 (470-520 cm dt.)	**0**		**1**		**10**	77	**2**		**0**		**13**
Layer 7 (520-580 cm dt.)	**1**		**0**		**6**	86	**0**		**0**		**7**
Layer 8 (580-720 cm dt.)	**0**		**1**		**6**	86	**0**		**0**		**7**
Layer 9 (620-740 cm dt.)	**1**		**1**		**7**	70	**1**		**0**		**10**
Total	**4**		**11**	8	**106**	81	**8**	6	**2**		**131**

Table 4.6.3.18 Nature of the distal edge of the partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The distal edge of the partial sumatraliths is very similar to the lateral edges; shaped on about 85% of the specimens. This frequency is slightly less than for the typical sumatraliths (more than 90%). The other distal edges, less than 10%, are formed by a fracture or cortical (**Table 4.6.3.18)**.

6.3) Nature of the proximal edge

Proximal side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cortex**		**Fracture**		**Removal Unifacial**		**Removal Bifacial**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**4**		**37**	65	**14**	25	**2**		**57**
Layer 4 (340-700 cm dt.)	**1**		**26**	76	**5**	15	**2**		**34**
Layer 5 (400-470 cm dt.)	**0**		**2**		**1**		**0**		**3**
Layer 6 (470-520 cm dt.)	**0**		**11**	84	**1**		**1**		**13**
Layer 7 (520-580 cm dt.)	**1**		**4**		**2**		**0**		**7**
Layer 8 (580-720 cm dt.)	**0**		**4**		**2**		**1**		**7**
Layer 9 (620-740 cm dt.)	**3**		**5**	50	**2**		**0**		**10**
Total	**9**	7	**89**	68	**27**	21	**6**	4	**131**

Table 4.6.3.19 Nature of the proximal edge of the partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The proximal edge of the partial sumatraliths is mostly made up of a fracture (68%: 89/131), otherwise it is shaped (25%: 33/131) almost always unifacially. In a few cases it is cortical **(Table 4.6.3.19)**.

7) Morpho-functional features of typical sumatraliths: Angle of the edges

7.1) Angle of right and left edges

Right side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**21**	37	**22**	39	**10**	17	**4**		**57**
Layer 4 (340-700 cm dt.)	**17**	50	**13**	38	**2**		**2**		**34**
Layer 5 (400-470 cm dt.)	**1**		**1**		**1**		**0**		**3**
Layer 6 (470-520 cm dt.)	**6**	46	**4**		**2**		**1**		**13**
Layer 7 (520-580 cm dt.)	**3**		**1**		**1**		**2**		**7**
Layer 8 (580-720 cm dt.)	**4**		**3**		**0**		**0**		**7**
Layer 9 (620-740 cm dt.)	**5**	60	**2**		**0**		**3**		**10**
Total	**57**	44	**46**	35	**16**	12	**12**	9	**131**

Left side **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**19**	33	**26**	46	**11**	19	**1**		**57**
Layer 4 (340-700 cm dt.)	**19**	56	**11**	32	**3**		**1**		**34**
Layer 5 (400-470 cm dt.)	**1**		**1**		**1**		**0**		**3**
Layer 6 (470-520 cm dt.)	**8**	61	**1**		**4**		**0**		**13**
Layer 7 (520-580 cm dt.)	**1**		**4**		**1**		**1**		**7**
Layer 8 (580-720 cm dt.)	**3**		**0**		**4**		**0**		**7**
Layer 9 (620-740 cm dt.)	**5**	50	**2**		**1**		**2**		**10**
Total	**56**	43	**45**	34	**25**	19	**5**	4	**131**

Table 4.6.3.20 Angle of right and left edges of the partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The lateral edges of the partial sumatraliths are quite similar in shapes like the typical sumatraliths. They are more acute or oblique (sharp to medium angled), with about 78% of the specimens, but some partial sumatraliths are also steep or steep-inverse, with about 22% (**Table 4.6.3.20)**.

7.2) Angle of distal edge

Distal side S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**33**	58	**18**	32	**6**	10	**0**		**57**
Layer 4 (340-700 cm dt.)	**24**	71	**9**	26	**0**		**1**		**34**
Layer 5 (400-470 cm dt.)	**1**		**1**		**1**		**0**		**3**
Layer 6 (470-520 cm dt.)	**10**	77	**0**		**1**		**2**		**13**
Layer 7 (520-580 cm dt.)	**4**		**3**		**0**		**0**		**7**
Layer 8 (580-720 cm dt.)	**3**		**2**		**1**		**1**		**7**
Layer 9 (620-740 cm dt.)	**5**	50	**1**		**2**		**2**		**10**
Total	**80**	61	**34**	26	**11**	8	**6**	5	**131**

Table 4.6.3.21 Angle of distal edge of the partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The distal edge of partial sumatraliths is more often acute than the lateral edges (61%: 80/131 against 43 or 44% for the lateral edges. Medium angled edges are also well represented (26%: 34/131) while open angled edges are infrequent, less than 10% **(Table 4.6.3.21)**.

7.3) Angle of proximal edge

Proximal side S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Acute**		**Oblique**		**Steep**		**Steep-inverse**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**5**	9	**14**	25	**31**	54	**7**	12	**57**
Layer 4 (340-700 cm dt.)	**5**	15	**13**	38	**14**	41	**2**		**34**
Layer 5 (400-470 cm dt.)	**0**		**2**		**0**		**1**		**3**
Layer 6 (470-520 cm dt.)	**0**		**5**	39	**6**	46	**2**		**13**
Layer 7 (520-580 cm dt.)	**1**		**1**		**4**		**1**		**7**
Layer 8 (580-720 cm dt.)	**1**		**2**		**2**		**2**		**7**
Layer 9 (620-740 cm dt.)	**2**		**2**		**1**		**5**	50	**110**
Total	**14**	11	**39**	30	**58**	44	**20**	15	**131**

Table 4.6.3.22 Angle of proximal edge of the partial sumatraliths from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The proximal edge of partial sumatraliths is mostly steep (open angled), with nearly 45% of the specimens plus 15% having “steep inverse” edges: it is also often medium angled: 30%. The acute edges are rare in proximal position **(Table 4.6.3.22)**. Therefore, the proximal end of the partial sumatraliths can be considered as the “prehensive” part of the tools, while the distal edges, mostly acute are the “transformative” or active part of these tools. This is different from the typical sumatraliths whose proximal edges are often acute or medium angled, with hardly one third of them being open angled.

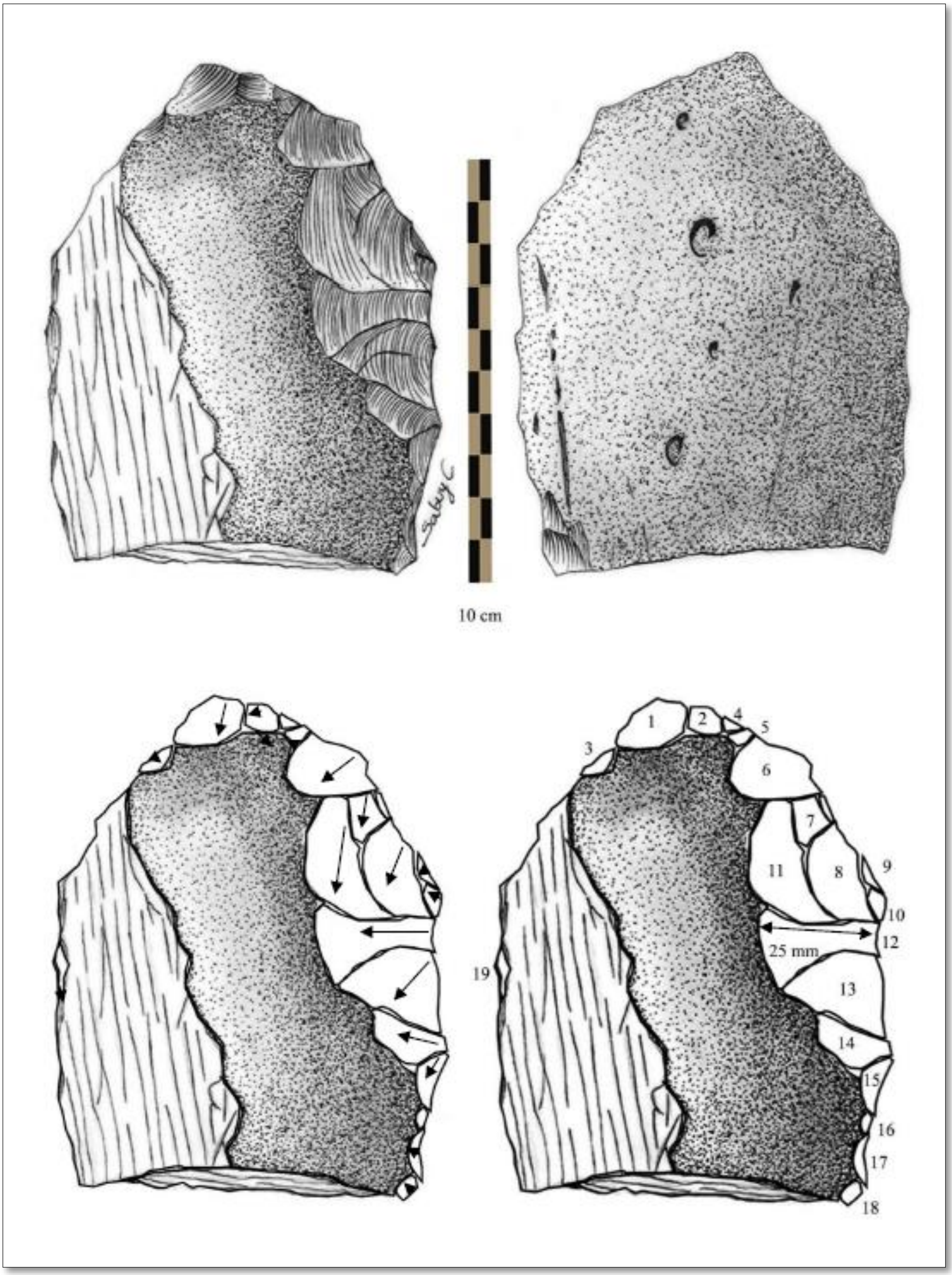


Figure 4.6.3.13 Main form of partial sumatralith found at Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4); illustrating the direction and number of removals and retouches (< 5 mm; drawings T. Chitkament)

4.7 Analysis of hammerstones from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

1) General features of the hammerstones

A total of 745 hammerstones (7% of the studied material) is analyzed from the layers 3 to 10 of area 2 sectors S20W10 and S21W10. The highest frequency is in the upper layers (3: 338= 9% and 4: 231=10%). In the other layers, they are less and in the lower layers they mostly occur in the sector S20W10-SEQ 3-4 **(Tables 4.2.2 & 4.7.1)**.

Hammerstones	**Layer 2**		**Layer 3**		**Layer 4**		**Layer 5**		**Layer 6**		**Layer 7**		**Layer 8**		**Layer 9**		**Layer 10**		**Total**
Numbers (%)	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
S20W10 (SEQ 3-4)	**17**	2	**338**	11	**228**	12	**0**		**0**		**0**		**61**	6	**40**	12	**42**	8	**726**
S21W10 (SEQ 3-4)	**3**		**3**		**3**		**5**	13	**2**		**9**	23	**12**	31	**1**		**1**		**39**
S21W10 (SEQ 1-2)	**-**		**-**		**-**		**8**	3	**11**	2	**2**		**-**		**-**		**-**		**21**
S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**20**		**341**	9	**231**	10	**5**	1	**2**		**9**	1	**73**	5	**41**	5	**43**	8	**745** (7%)
Lithic Artefacts S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)			**3611**		**2266**		**689**		**232**		**1258**		**1371**		**789**		**524**		**10740**

Table 4.7.1 Total number of hammerstones in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4), S21W10 (SEQ 3-4) and S21W10 (SEQ 1-2)

Raw materials S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Gray sandstone**		**Black sandstone**		**Granite**		**Quartz**		**Quart-zite**		**Mudstone**		**Siliceous shale**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**311**	91	**0**		**17**	5	**6**	2	**7**	2	**0**		**0**		**341**
Layer 4 (340-700 cm dt.)	**207**	90	**3**		**2**		**7**	3	**6**	3	**5**	2	**1**		**231**
Layer 5 (400-470 cm dt.)	**4**	80	**1**		**0**		**0**		**0**		**0**		**0**		**5**
Layer 6 (470-520 cm dt.)	**2**		**0**		**0**		**0**		**0**		**0**		**0**		**2**
Layer 7 (520-580 cm dt.)	**9**	100	**0**		**0**		**0**		**0**		**0**		**0**		**9**
Layer 8 (580-720 cm dt.)	**66**	90	**0**		**2**		**2**		**2**		**1**		**0**		**73**
Layer 9 (620-740 cm dt.)	**36**	88	**1**		**1**		**1**		**2**		**0**		**0**		**41**
Layer 10 (700-780 cm dt.)	**36**	84	**1**		**1**		**2**		**2**		**1**		**0**		**43**
Total	**671**	90	**6**	1	**23**	3	**18**	2	**19**	3	**7**	1	**1**		**745**

Table 4.7.2 The raw materials of hammerstones from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Around 90% (671/745) of the hammerstones are in gray sandstone, and in all the layers this raw material is more than 80%. The other raw materials like granite, quartz, quartzite, mudstone and siliceous shale are rare (**Table 4.7.2, figure 4.7.1**).

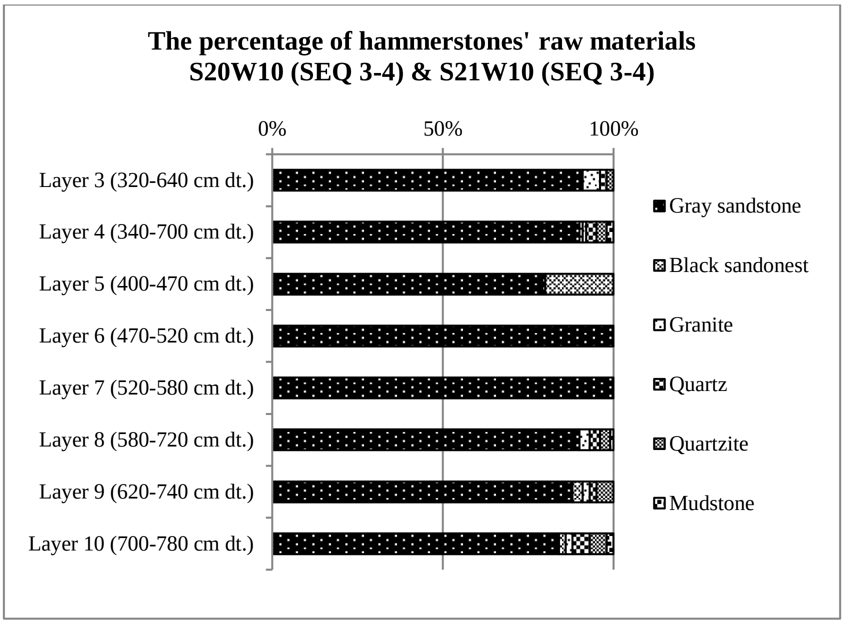


Figure 4.7.1 Distribution of the raw materials of hammerstones from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

2) Measurements

Measurement **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Length (mm)**	**Width (mm)**	**Thickness (mm)**	**Number of hammerstones**
Layer 3 (320-340 cm dt.)	89	64	44	341
Layer 4 (340-400 cm dt.)	87	62	41	231
Layer 5 (400-470 cm dt.)	89	69	45	5
Layer 6 (470-520 cm dt.)	74	56	36	2
Layer 7 (520-580 cm dt.)	106	75	52	9
Layer 8 (580-620 cm dt.)	85	62	44	73
Layer 9 (620-700 cm dt.)	87	59	39	41
Layer 10 (700-720 cm dt.)	99	70	45	43
Average	**89**	**64**	**43**	**745**

Table 4.7.3 Average dimensions of the hammerstones from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The average dimensions (length, width and thickness) of the hammerstones are quite similar in all the layer, varying between 85 and 99 mm for the length, between 59 and 75 mm for the width and between 39 and 52 mm for the thickness, except for the two hammerstones of layer 6 which are smaller. The biggest hammerstones are in the layer 7 **(Table 4.7.3, figures 4.7.4 & 4.7.5)**.

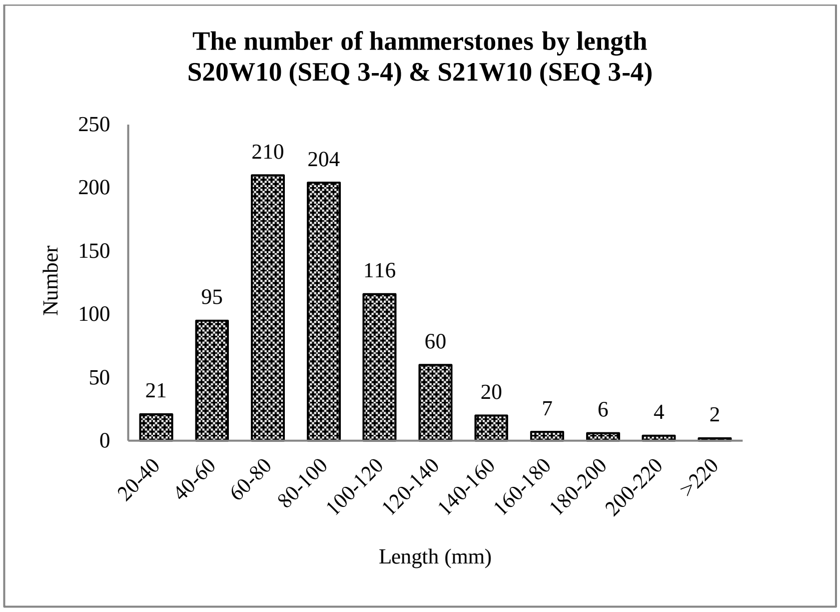


Figure 4.7.2 Distribution of the hammerstones by length from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

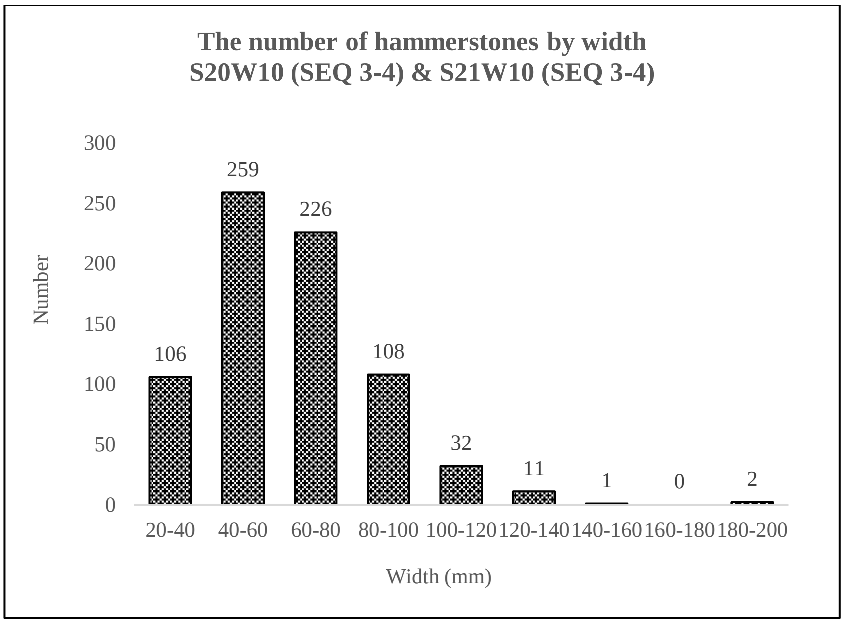


Figure 4.7.3 Distribution of the hammerstones by width from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

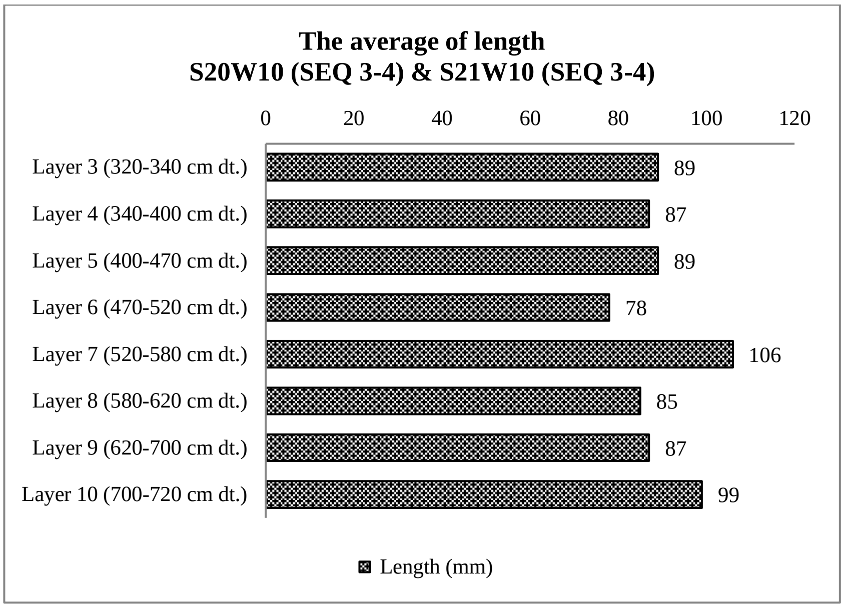


Figure 4.7.4 Distribution of the average length of the hammerstones across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

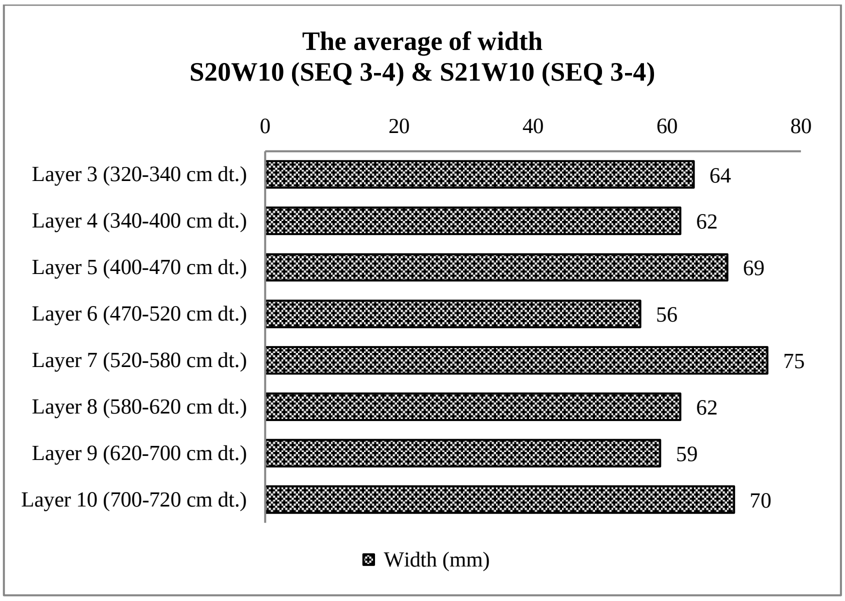


Figure 4.7.5 Distribution of the average width of the hammerstones across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Weight in (gr.) **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4**	**<200**	**201-400**	**401-600**	**601-800**	**801-1000**	**1001-1200**	**1201-1400**	**1401-1600**	**1601-1800**	**1801-2000**	**>2000**	**Total**
Layer 3 (320-640 cm dt.)	134	89	38	31	18	6	8	1	4	3	9	**341**
Layer 4 (340-700 cm dt.)	79	75	38	15	8	6	4	2	1	2	1	**231**
Layer 5 (400-470 cm dt.)	1	2	2	0	0	0	0	0	0	0	0	**5**
Layer 6 (470-520 cm dt.)	1	1	0	0	0	0	0	0	0	0	0	**2**
Layer 7 (520-580 cm dt.)	1	1	4	1	1	0	1	0	0	0	0	**9**
Layer 8 (580-720 cm dt.)	27	23	10	6	1	2	0	4	0	0	0	**73**
Layer 9 (620-740 cm dt.)	19	8	6	1	4	2	0	1	0	0	0	**41**
Layer 10 (700-780 cm dt.)	12	10	9	5	1	3	2	0	1	0	0	**43**
Total	**274**	**209**	**107**	**59**	**33**	**19**	**15**	**8**	**6**	**5**	**10**	**745**

Table 4.7.4 The weight (in gram) of hammerstones from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The weight of hammerstones ranges from less than 200 g to more than 2000 g but most of them are between less than 200 g and 400 g (483 tools: 65%), with predominance of values less than 200 g (274: 37%). The maximal weight is found in the layer 3 around 4800 g **(Table 4.7.4, figure 4.7.6)**.

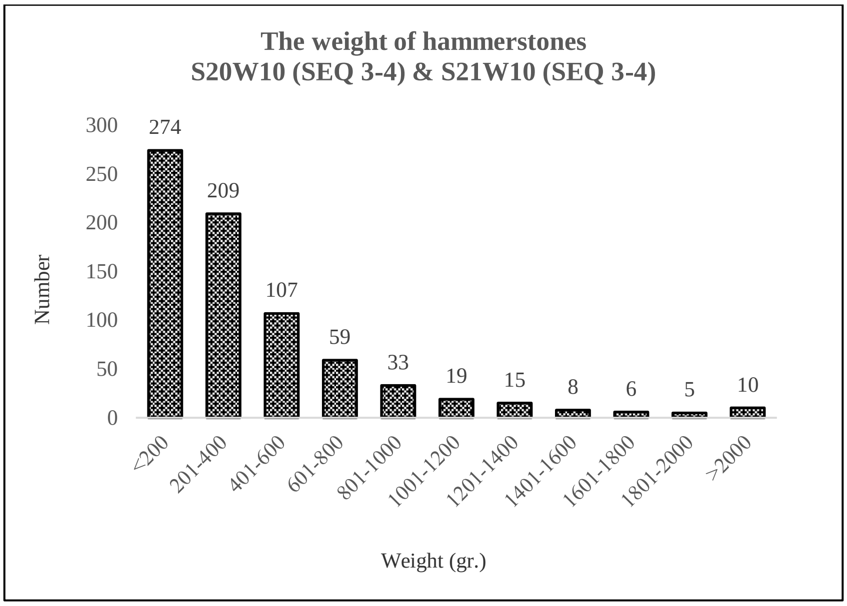


Figure 4.7.6 Distribution of the weight (in gram) of hammerstones from Tham Lod Rockshelter, area 2 sectors S21W10 (SEQ 3-4) & S20W10 (SEQ 3-4)

3) Blank of hammers

3.1) Type of blanks

Type of blank **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cobble**		**Broken cobble**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**141**	41	**200**	59	**341**
Layer 4 (340-700 cm dt.)	**74**	32	**157**	68	**231**
Layer 5 (400-470 cm dt.)	**3**		**2**		**5**
Layer 6 (470-520 cm dt.)	**2**		**0**		**2**
Layer 7 (520-580 cm dt.)	**2**		**7**	78	**9**
Layer 8 (580-720 cm dt.)	**28**	38	**45**	62	**73**
Layer 9 (620-740 cm dt.)	**11**	27	**30**	73	**41**
Layer 10 (700-780 cm dt.)	**17**	40	**26**	60	**43**
Total	**278**	37	**467**	63	**745**

Table 4.7.5 Blanks of the hammerstones from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Approximately 63% (467/745) of the hammerstones are broken cobbles and the other ones are whole cobbles (37%: 278/745). It is interesting to note that both supports are not variable between the layers (**Table 4.7.5**).

3.2) Type of fractures

Type of artefacts **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Oblique**		**Perpendicular**		**Split**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**26**	13	**146**	73	**27**	14	**199**
Layer 4 (340-700 cm dt.)	**37**	23	**100**	62	**24**	15	**161**
Layer 5 (400-470 cm dt.)	**1**		**1**		**0**		**2**
Layer 7 (520-580 cm dt.)	**0**		**6**	86	**1**		**7**
Layer 8 (580-720 cm dt.)	**14**	31	**25**	54	**7**	15	**46**
Layer 9 (620-740 cm dt.)	**5**	16	**21**	68	**5**	16	**31**
Layer 10 (700-780 cm dt.)	**5**	19	**19**	70	**3**		**27**
Total	**88**	19	**318**	67	**67**	14	**573**

Table 4.7.6 Type of fractures of the hammerstones from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

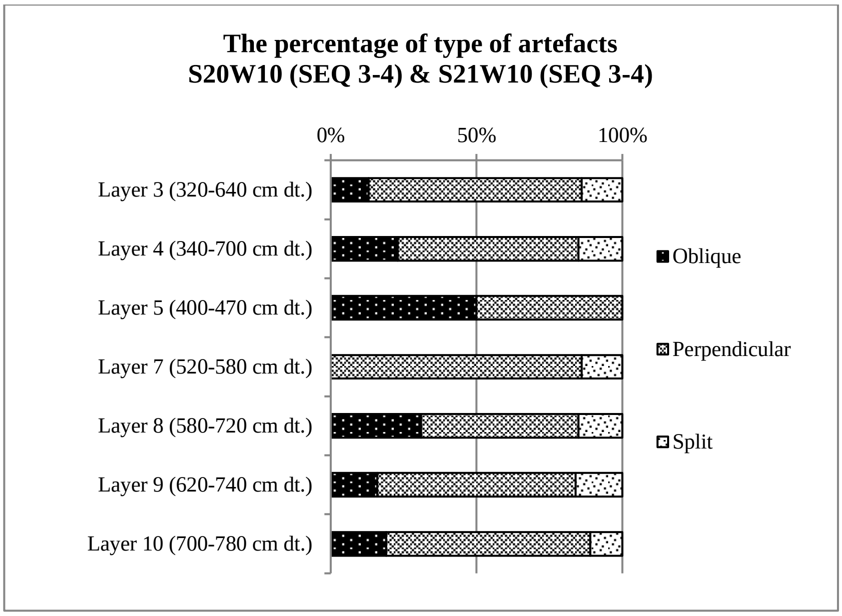


Figure 4.7.7 Distribution of the type of fractures on the hammerstones from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

For the hammer fractures, the perpendicular type is the most frequent in these sectors, providing 67% (318/573) of the fractures. This is approximately the same in all the layers. Then the oblique fracture and split are representing around 1/3 of the cases **(Table 4.7.6, figure 4.7.7)**.

It is to be noted that there are more fractures (573 specimens) than broken cobbles (467 specimens) because several fractures may be found on one specimen, especially in the upper layers 3 to 4.

4) General morphology of hammerstones

In the frontal view, the oval shape is the most common in the sectors, with 30%, followed by the half-oval, around 28% of the hammerstones. Both of shapes are quite constant among the layers (**Tables 4.7.7**)

Frontal view **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Oval**		**Half-oval**		**Trape-zoidal**		**Irregular**		**Trian-gular**		**Circular**		**D-shape**		**Penta-gonal**		**Bi-convex**		**Concave-convex**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**120**	35	**82**	24	**44**	13	**22**	6	**17**	5	**23**	7	**15**	4	**12**	4	**3**		**3**		**341**
Layer 4 (340-700 cm dt.)	**51**	22	**82**	36	**29**	13	**23**	10	**21**	9	**12**	5	**5**	2	**7**	3	**1**		**0**		**231**
Layer 5 (400-470 cm dt.)	**2**		**2**		**0**		**0**		**0**		**1**		**0**		**0**		**0**		**0**		**5**
Layer 6 (470-520 cm dt.)	**1**		**0**		**0**		**0**		**0**		**1**		**0**		**0**		**0**		**0**		**2**
Layer 7 (520-580 cm dt.)	**1**		**4**		**2**		**2**		**0**		**0**		**0**		**0**		**0**		**0**		**9**
Layer 8 (580-720 cm dt.)	**20**	27	**22**	29	**10**	14	**8**	11	**3**		**5**	7	**4**		**0**		**1**		**0**		**73**
Layer 9 (620-740 cm dt.)	**11**	27	**10**	24	**7**	17	**3**		**6**	15	**1**		**1**		**0**		**2**		**0**		**41**
Layer 10 (700-780 cm dt.)	**14**	33	**3**		**3**		**5**	11	**5**	12	**2**		**6**	14	**2**		**1**		**2**		**43**
Total	**220**	30	**205**	28	**95**	13	**63**	8	**52**	7	**45**	6	**31**	4	**21**	3	**8**	1	**5**	1	**745**

Table 4.7.7 The frontal view of hammerstones from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

5) Hammering marks

5.1) Type of hammering marks

Type of hammering marks **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Pounding**		**Chipping**		**Both**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**259**	76	**2**		**80**	23	**341**
Layer 4 (340-700 cm dt.)	**169**	73	**7**	3	**55**	24	**231**
Layer 5 (400-470 cm dt.)	**5**	100	**0**		**0**		**5**
Layer 6 (470-520 cm dt.)	**2**		**0**		**0**		**2**
Layer 7 (520-580 cm dt.)	**4**		**1**		**4**		**9**
Layer 8 (580-720 cm dt.)	**55**	75	**3**		**15**	21	**73**
Layer 9 (620-740 cm dt.)	**17**	42	**5**	12	**19**	46	**41**
Layer 10 (700-780 cm dt.)	**18**	42	**1**		**24**	56	**43**
Total	**529**	71	**19**	3	**197**	26	**745**

Table 4.7.8 Types of hammering marks on hammerstones from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

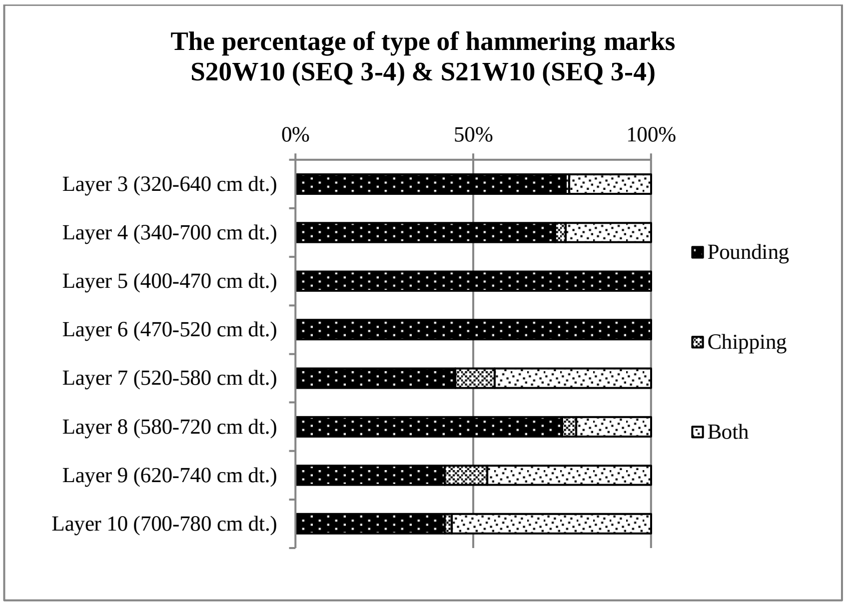


Figure 4.7.8 Distribution of the type of hammering marks on hammerstones from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The hammerstones have mostly pounding marks: 71% (529/745), thereafter pounding marks are combined with chipping, representing 26% (197/745). Chipping marks alone are rare in these sectors **(Table 4.7.8, figure 4.7.8)**.

5.2) Intensity of hammering marks

Intensity of hammering marks **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**High**		**Medium**		**Low**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**70**	21	**198**	58	**73**	21	**341**
Layer 4 (340-700 cm dt.)	**72**	31	**46**	20	**113**	49	**231**
Layer 5 (400-470 cm dt.)	**1**		**0**		**4**		**5**
Layer 6 (470-520 cm dt.)	**0**		**1**		**1**		**2**
Layer 7 (520-580 cm dt.)	**0**		**8**	89	**1**		**9**
Layer 8 (580-720 cm dt.)	**17**	23	**34**	47	**22**	30	**73**
Layer 9 (620-740 cm dt.)	**11**	27	**15**	36	**15**	37	**41**
Layer 10 (700-780 cm dt.)	**15**	35	**20**	46	**8**	19	**43**
Total	**186**	24	**322**	44	**237**	32	**745**

Table 4.7.9 Intensity of hammering marks on hammerstones from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

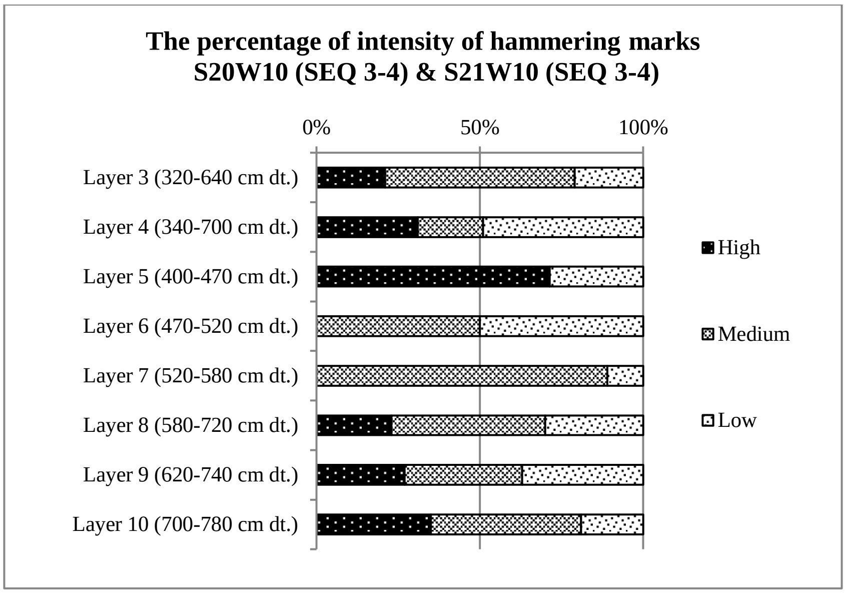


Figure 4.7.9 Distribution of the intensity of hammering marks on hammerstones from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Most of the marks on hammerstones are of medium intensity: 44% (322/745) and this is more noticeable in the layer 7 (8/9: 89%). However in the layer 4, these marks are mostly of low intensity (49%: 113/231). Low or high intensity hammering marks represent each between 20% and 35% of the cases, but this varies a lot between the layers. High intensity marks are especially frequent in the lower layer 10 (15/43: 35%; **Table 4.7.9, figure 4.7.9)**.

5.3) Location of hammering marks

Location of use marks S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Right side**		**Left side**		**Distal side**		**Proximal side**		**Upper face**		**Lower face**		**Total**
Layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3	**259**	17	**282**	19	**246**	16	**324**	22	**206**	14	**181**	12	**1428**
Layer 4	**172**	18	**177**	19	**147**	16	**217**	23	**112**	12	**107**	12	**932**
Layer 5	**2**		**2**		**4**		**4**		**1**		**1**		**14**
Layer 6	**1**		**1**		**1**		**2**		**1**		**1**		**7**
Layer 7	**4**		**2**		**9**	43	**5**	24	**0**		**1**		**21**
Layer 8	**43**	18	**39**	16	**48**	20	**61**	26	**25**	11	**22**	9	**238**
Layer 9	**21**	15	**24**	18	**23**	17	**36**	27	**15**	11	**16**	12	**135**
Layer 10	**25**	15	**29**	18	**27**	17	**39**	24	**22**	14	**19**	12	**161**
Total	**527**	17	**556**	18	**505**	17	**688**	23	**382**	13	**348**	12	**2936**

Figure 4.7.10 Location of use marks of hammerstones from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The use marks of hammerstones are most of the time localized at the proximal end, the widest end (23%: 688/2936). Then with the same frequency, they are at the distal end or on the lateral sides (17-18%). They can also occur on the upper or lower face (12-13%). These frequencies are quite constant across the stratigraphy. Of course, there may be marks at several locations of a hammerstone **(Table 4.7.10)**.

6) Reddening / Burning on hammerstones

Burning S20W10 (SEQ 3-4)	**Entirely**		**Cortex only**		**Some parts of cortex**		**Total**	
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%
Layer 3 (540-640 cm dt)	**24**	71	**10**	29	**0**		**34**	10
Layer 4 (640-700 cm dt)	**10**	71	**4**	29	**0**		**14**	6
Layer 8 (700-720 cm.dt)	**2**		**0**		**1**		**3**	4
Layer 9 (720-740 cm dt)	**1**		**0**		**0**		**1**	1/41
Total	**37**	71	**14**	27	**1**	2	**52**	7

Table 4.7.11 Reddening/**b**urning marks on hammerstones from area 2 sector S20W10 (SEQ 3-4)

It is interesting to note that some of the hammerstones are reddened, probably due to heating by fire; these mostly occur in the sector S20W10. In most of the cases (71%: 37/52),, they are entirely reddened on their surface and otherwise (27%; 14/52) only the cortex is reddened, suggesting that they were burnt, if at all this is due to burning, before they were used or broken **(Table 4.7.11)**.

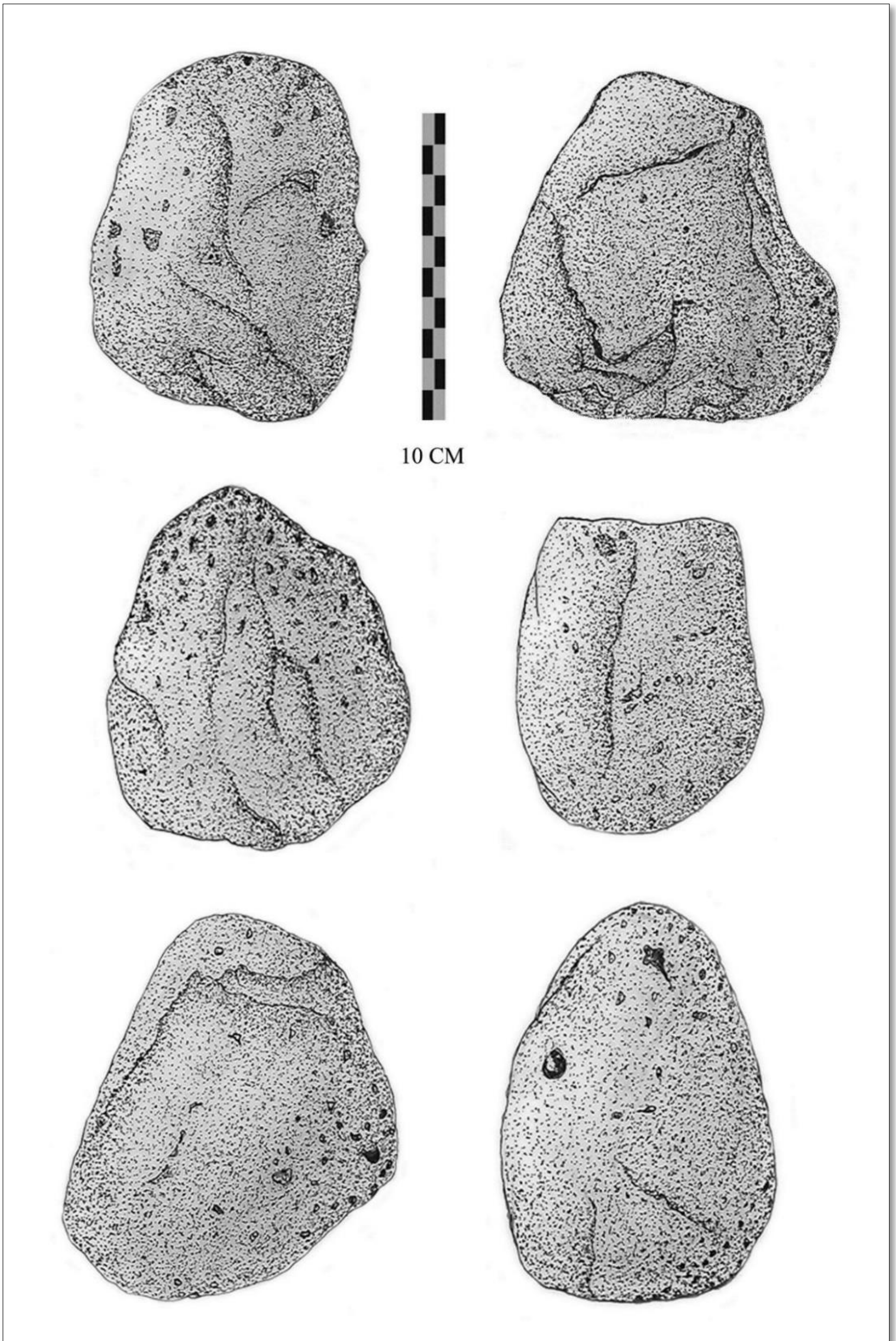


Figure 4.7.10 Main forms of hammerstones found at Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4; drawings T. Chitkament)

4.8 Analysis of the big fragments from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

1) General features of the big fragments

A total of 319 (3% of the studied material) big fragments is analysed from stratigraphic layers 3 to 10 of area 2, sectors S20W10 & S21W10. The greatest proportion is in the upper layers (3: 184=5% and 4: 85=4%), and the proportions are quite lower in the other layers **(Tables 4.2.1 & 4.8.1)**. It is to be reminded that the big fragments are rare in the sector S21W10, especially in the SEQ 3-4 where they are absent.

Big fragments	**Layer 2**		**Layer 3**		**Layer 4**		**Layer 5**		**Layer 6**		**Layer 7**		**Layer 8**		**Layer 9**		**Layer 10**		**Total**
Numbers (%)	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
S20W10 (SEQ 3-4)	**27**	4	**184**	6	**85**	5	**0**		**0**		**0**		**25**	3	**11**	3	**14**	3	**346**
S21W10 (SEQ 1-2)	**-**		**-**		**-**		**40**	14	**20**	3	**1**	2	**-**		**-**		**-**		**63**
S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**27**		**184**	5	**85**	4							**25**	2	**11**	1	**14**	3	**319** (3%)
Lithic artefacts S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)			**3611**		**2266**		**689**		**232**		**1258**		**1371**		**789**		**524**		**10740**

Table 4.8.1 Total number of big fragments in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4), S21W10 (SEQ 3-4) & S21W10 (SEQ 1-2)

Raw materials S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Gray sandstone**		**Black sandstone**		**Mud-stone**		**Quartz**		**Quart-zite**		**Granite**		**Siliceous shale**		**Zeolite**		**Total**
Layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	N
Layer 3	**153**	83	**19**	10	**0**		**5**	3	**7**	4	**0**		**0**		**0**		**184**
Layer 4	**64**	76	**1**		**1**		**0**		**18**	21	**1**		**0**		**0**		**85**
Layer 8	**17**	68	**1**		**0**		**0**		**6**	24	**0**		**1**		**0**		**25**
Layer 9	**8**	73	**0**		**0**		**1**		**1**		**0**		**0**		**1**		**11**
Layer 10	**11**	79	**0**		**0**		**0**		**3**		**0**		**0**		**0**		**14**
Total	**253**	79	**21**	7	**1**		**6**	2	**35**	11	**1**		**1**		**1**		**319**

Table 4.8.2 The raw materials of big fragments from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Numerous big fragments are made in gray sandstone, nearly 80% (253/319) of the cases. The other raw materials such as black sandstone, mudstone, quartz, granite, siliceous shale and zeolite are rare, except the quartzite in the layers 4 and 8 where the percentage reaches 21-24% **(Table 4.8.2)**.

2) Measurements

Measurement **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Length (mm)**	**Width (mm)**	**Thickness (mm)**	**Number of big fragments**
Layer 3 (320-640 cm dt.)	127	80	52	184
Layer 4 (340-700 cm dt.)	125	75	49	85
Layer 8 (580-720 cm dt.)	121	70	43	25
Layer 9 (620-740 cm dt.)	122	89	48	11
Layer 10 (700-780 cm dt.)	133	88	58	14
Average	**126**	**79**	**50**	**319**

Table 4.8.3 Average dimensions of big fragments from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The average measurements of big fragments are rather similar from layer to layer, often between 127 and 121 mm for the length and between 89 and 75 mm for the width; only in the bottom layer 10 fragments are longer (133 mm) and in the layer 8 they are narrower (70 mm). The average thickness is equal to 50 mm, and as for the length, the maximal value is in the layer 10, around 58 mm **(Table 4.8.3, figures 4.8.4 & 4.8.5)**.

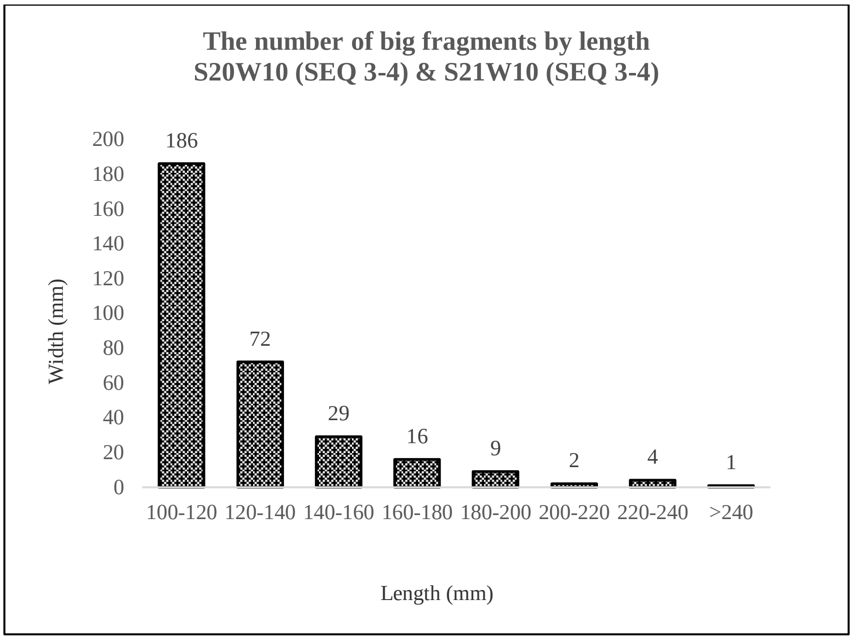


Figure 4.8.1 Distribution of the big fragments by length from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

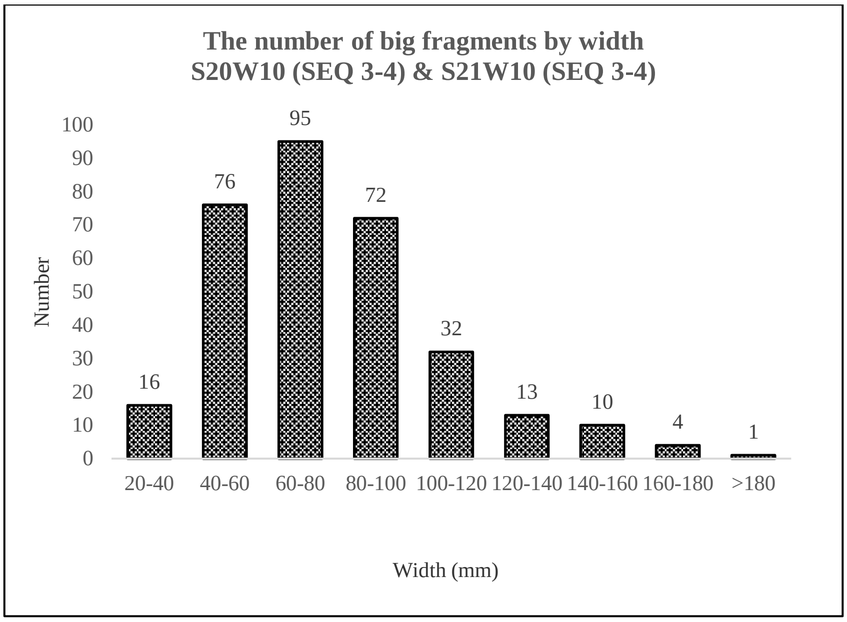


Figure 4.8.2 Distribution of the big fragments by width from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

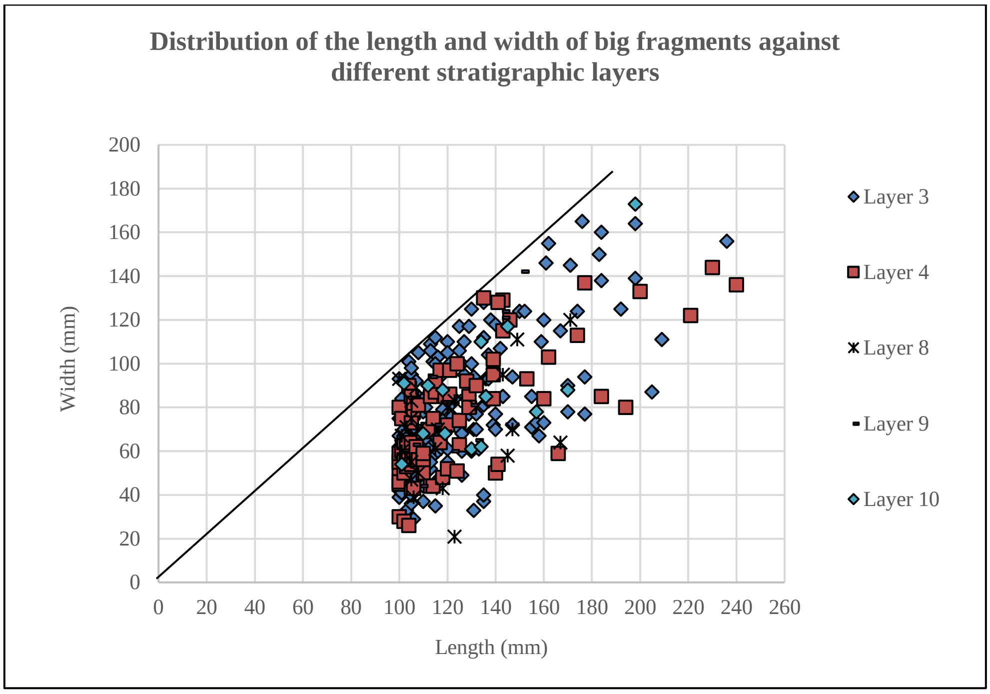


Figure 4.8.3 Scatter diagram length x width of the big fragments from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

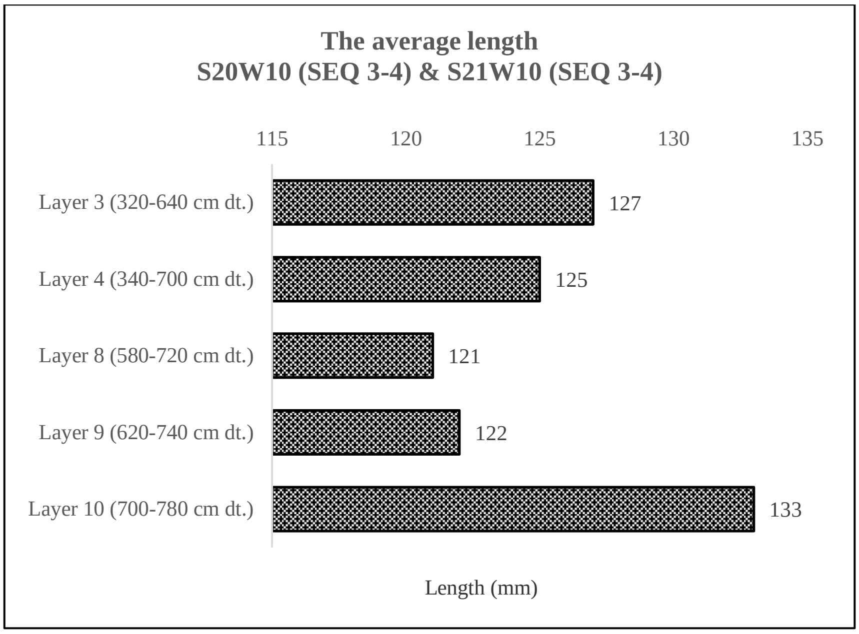


Figure 4.8.4 Distribution of the average length of the big fragments across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

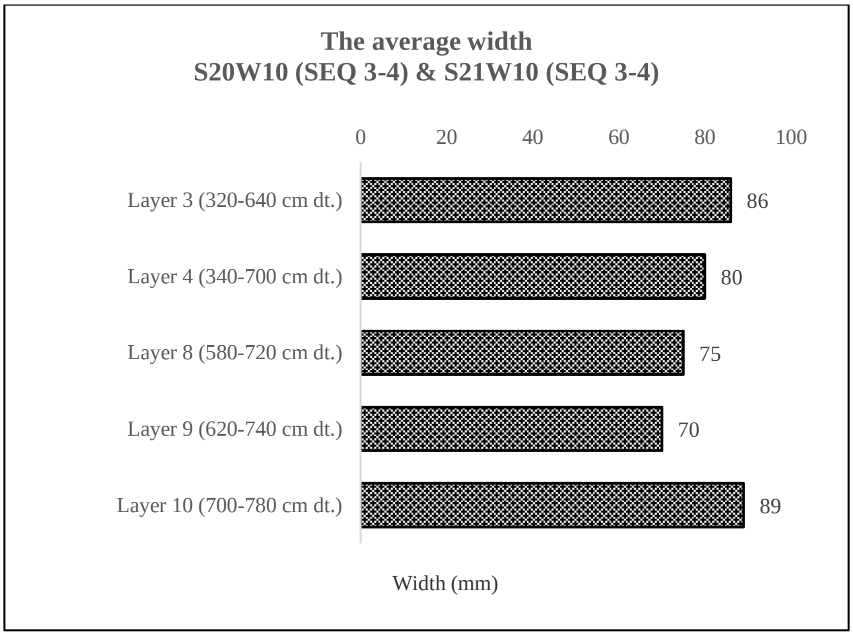


Figure 4.8.5 Distribution of the average width of the big fragments across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Weight (gr) **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**<200**	**201-400**	**401-600**	**601-800**	**801-1000**	**1001-1200**	**1201-1400**	**1401-1600**	**1601-1800**	**>1800**	**Total**
Layer 3 (320-640 cm dt.)	21	42	41	17	19	13	5	6	7	13	**184**
Layer 4 (340-700 cm dt.)	13	29	16	5	3	5	4	3	1	6	**85**
Layer 8 (580-720 cm dt.)	3	9	3	5	2	2	0	1	0	0	**25**
Layer 9 (620-740 cm dt.)	1	3	3	1	0	0	1	1	0	1	**11**
Layer 10 (700-780 cm dt.)	0	3	4	2	1	1	0	2	0	1	**14**
Total	**38**	**86**	**67**	**30**	**25**	**21**	**10**	**13**	**8**	**21**	**319**

Table 4.8.4 The weight (in gram) of big fragments from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

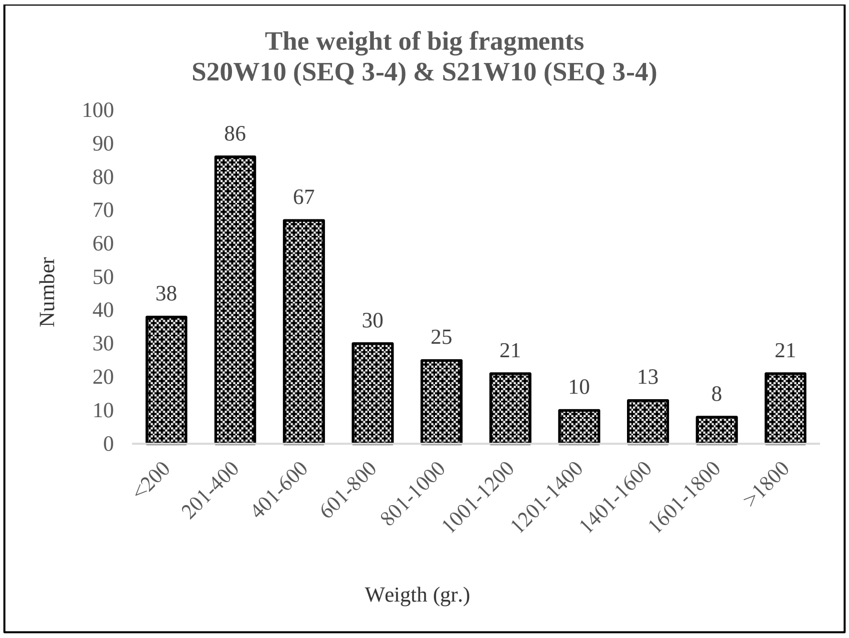


Figure 4.8.6 Distribution of the weight (in gram) of big fragments from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The weights of the big fragments are ranging from less than 200 g to more than 1800 g, but their values are concentrated in a main group between 201 g and 600 g (153 tools: 48%). The other weight classes are gradually decreasing and hardly one fourth of them weigh more than 1000 g; the maximal weight is around 6200 g, in the layer 4 **(Table 4.8.4, figure 4.8.6)**.

The main supports of big fragments are broken cobbles, dominant in all the layers.

3) Type of fractures of the big fragments

3.1) Type of fractures

Type of features **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Oblique**		**Perpendicular**		**Split**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**8**	4	**148**	81	**28**	15	**184**
Layer 4 (340-700 cm dt.)	**3**		**57**	67	**25**	29	**85**
Layer 8 (580-720 cm dt.)	**2**		**18**	72	**5**	20	**25**
Layer 9 (620-740 cm dt.)	**3**		**6**	55	**2**		**11**
Layer 10 (700-780 cm dt.)	**1**		**10**	72	**3**		**13**
Total	**17**	5	**239**	75	**63**	20	**319**

Table 4.8.5 Type of fractures of the big fragments from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ3-4) & S21W10 (SEQ 3-4)

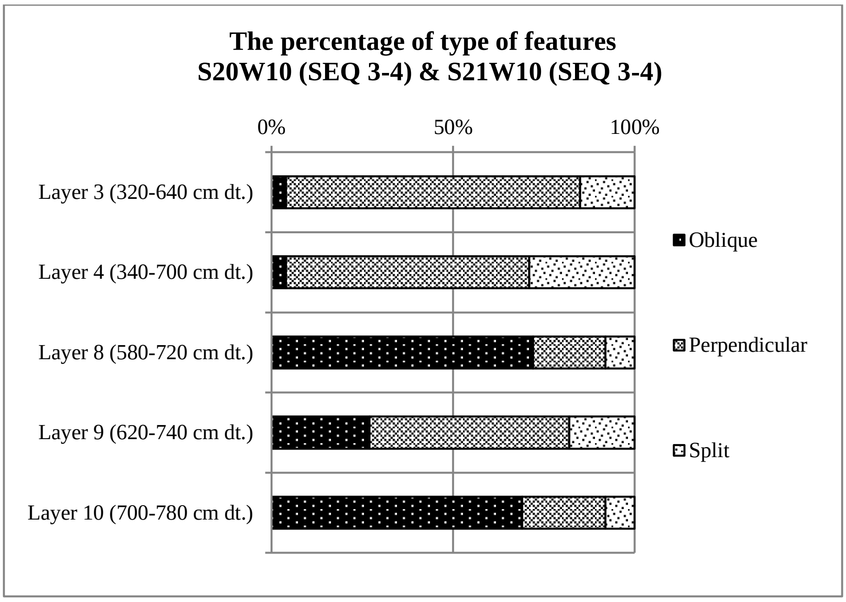


Figure 4.8.7 Distribution of the type of fractures of the big fragments from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The fractures of big fragments are generally perpendicular, with about 75% of the cases (239/319). In the different layers it varies between 55 and 80%, then oblique fractures and "split" (split is a fracture along the grand plane of the cobble) are quite variable in the layers, representing 1/3 of the cases **(Table 4.8.5, figure 4.8.7)**.

4) General morphology of big fragments

Frontal view **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Irregular**		**Trape-zoidal**		**Trian-gular**		**Penta-gonal**		**Oval**		**D-shape**		**Half-oval**		**Almond**		**Circular**		**Convex-concave**		**Polygonal**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**58**	31	**53**	29	**19**	10	**22**	12	**19**	11	**6**	3	**4**		**1**		**1**		**0**		**1**		**184**
Layer 4 (340-700 cm dt.)	**26**	31	**21**	25	**14**	17	**9**	11	**8**	9	**2**		**3**		**2**		**0**		**0**		**0**		**85**
Layer 8 (580-720 cm dt.)	**16**	64	**4**		**4**		**1**		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**25**
Layer 9 (620-740 cm dt.)	**4**		**0**		**4**		**1**		**0**		**1**		**0**		**0**		**0**		**1**		**0**		**11**
Layer 10 (700-780 cm dt.)	**5**	36	**3**		**1**		**0**		**1**		**1**		**0**		**1**		**1**		**1**		**0**		**14**
Total	**109**	34	**81**	26	**42**	13	**33**	10	**28**	9	**10**	3	**7**	2	**4**	4/319	**2**		**2**		**1**		**319**

Table 4.8.6 The frontal view of big fragments from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The general morphology of big fragments is often irregular, for nearly 35% (109/319) of the specimens and this is preponderant in the layer 8 (64%: 16/25); the trapezoidal shape comes second, representing 26% (81/319). The other shapes are infrequent and represent around 40% in total **(Table 4.8.6)**.

5) Location of fracture of the big fragments

Location of fractures **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Right side**		**Left side**		**Distal side**		**Proximal side**		**Number of fractures**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**151**	27	**146**	26	**145**	26	**114**	21	**556**
Layer 4 (340-700 cm dt.)	**60**	26	**51**	22	**68**	30	**50**	22	**229**
Layer 8 (580-720 cm dt.)	**21**	29	**18**	24	**23**	31	**12**	16	**74**
Layer 9 (620-740 cm dt.)	**10**	31	**8**	25	**9**	28	**5**	16	**32**
Layer 10 (700-780 cm dt.)	**9**	24	**10**	26	**10**	26	**9**	24	**38**
Total	**251**	27	**233**	25	**255**	27	**190**	21	**929**

Table 4.8.7 Location of fractures of the big fragments from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The fractures occur with the same frequency on each of the lateral sides and the distal side but they are slightly less frequent on the proximal side (**Table 4.8.7)**

6) Location of the damages on big fragments

6.1) Pounding of the edges

Location of the pounding **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Right side**		**Left side**		**Distal side**		**Proximal side**		**Total**	
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	% of big fragments with pounding marks
Layer 3 (540-640 cm dt.)	**19**	17	**21**	19	**28**	25	**44**	39	**112**	35
Layer 4 (640-700 cm dt.)	**8**	25	**8**	25	**6**	19	**10**	31	**32**	25
Layer 8 (700-720 cm dt.)	**1**		**1**		**3**		**4**		**9**	32
Layer 9 (720-740 cm dt.)	**0**		**0**		**0**		**2**		**2**	2/11
Layer 10 (740-780 cm dt.)	**3**		**0**		**2**		**5**	50	**10**	36
Total	**31**	19	**30**	18	**39**	24	**65**	39	**165**	31

Table 4.8.8 Location of the pounding marks on big fragments from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

6.2) Chipping of the edges

Location of the chipping **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Right side**		**Left side**		**Distal side**		**Proximal side**		**Total**	
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	% of big fragments with chipping
Layer 3 (540-640 cm dt.)	**4**		**1**		**5**	42	**2**		**12**	5
Layer 4 (640-700 cm dt.)	**1**		**2**		**2**		**4**		**9**	8
Layer 8 (700-720 cm dt.)	**1**		**2**		**2**		**1**		**6**	3/25
Layer 9 (720-740 cm dt.)	**1**		**0**		**1**		**1**		**3**	1/11
Layer 10 (740-780 cm dt.)	**1**		**2**		**1**		**1**		**5**	4/14
Total	**8**	23	**7**	20	**11**	31	**9**	26	**35**	8

Table 4.8.9 Location of the chipping on big fragments from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

7) Reddening/Burning of big fragments

Burning of big fragments **S20W10 (SEQ 3-4) & S20W10 (SEQ 3-4)**	**Entirely**		**Cortex only**		**Total**	
Stratigraphic layers	**N**	%	**N**	%	**N**	% of burned big fragments
Layer 3 (320-640 cm dt.)	**20**	77	**6**	23	**26**	14
Layer 4 (340-700 cm dt.)	**6**	75	**2**		**8**	9
Layer 8 (580-720 cm dt.)	**1**		**0**		**1**	1/25
Layer 9 (620-740 cm dt.)	**1**		**0**		**1**	1/11
Total	**28**	78	**8**	22	**36**	11

Table 4.8.10 Burning of the big fragments from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Some of the big fragments show some reddening, which can be suspected of being due to burning. Their frequency ranges from nil in the layer 10 to 14% in the layer 3. In most of the cases (78%: 28/36), the surface of the fragments is entirely reddened, suggesting that the burning happened after the breakage. In the other cases (22%: 8/36) only the cortex is reddened **(Table 4.8.10)**.

4.9 Analysis of small fragments from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The small fragments are representing 67% (7222/10740) of the studied material from the stratigraphic layers 3 to 10 of area 2 sectors S20W10 and S21W10. They are the major part of the assemblages in all the layers, especially in the layer 7 (83%; **Tables 4.2.2, 4.9.1)**.

Small sized of fragments **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Flake fragments**		**Small amorphous fragments**		**Pebble fragments**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**615**	26	**1788**	74	**6**	0	**2409** (67)
Layer 4 (340-700 cm dt.)	**582**	46	**677**	53	**12**	1	**1271** (56)
Layer 5 (400-470 cm dt.)	**400**	80	**46**	9	**55**	11	**501** (73)
Layer 6 (470-520 cm dt.)	**100**	61	**65**	39	**0**		**165** (71)
Layer 7 (520- 580 cm dt.)	**683**	66	**317**	30	**43**	4	**1043** (83)
Layer 8 (580-720 cm dt.)	**421**	44	**532**	55	**8**	1	**961** (70)
Layer 9 (620-740 cm dt.)	**240**	50	**226**	48	**9**	2	**475** (60)
Layer 10 (700-780 cm dt.)	**40**	10	**357**	90	**0**		**397** (76)
Total	**308**	43	**4008**	55	**133**	2	**7222**

Table 4.9.1 Total number of small fragments in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

1) Flake fragments

1.2 Raw materials

Flake fragments **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Gray sandstone**		**Black sandstone**		**Quartz**		**Siliceous shale**		**Mudstone**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**529**	86	**86**	14	**0**		**0**		**0**		**615**
Layer 4 (340-700 cm dt.)	**545**	94	**37**	6	**0**		**0**		**0**		**582**
Layer 5 (400-470 cm dt.)	**380**	95	**7**	2	**1**		**12**	3	**0**		**400**
Layer 6 (470-520 cm dt.)	**98**	98	**2**		**0**		**0**		**0**		**100**
Layer 7 (520- 580 cm dt.)	**606**	89	**76**	11	**1**		**0**		**0**		**683**
Layer 8 (580-720 cm dt.)	**366**	87	**49**	12	**0**		**0**		**6**	1	**421**
Layer 9 (620-740 cm dt.)	**230**	96	**9**	4	**1**		**0**		**0**		**240**
Layer 10 (700-780 cm dt.)	**23**	57	**9**	23	**0**		**8**	20	**0**		**40**
Total	**2777**	90	**275**	9	**3**		**20**	1	**6**	0	**3081**

Table 4.9.2 The raw materials of flake fragments from Tham Lod Rockshelter, 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The proportion of flake fragments within the fragments is extremely variable between the layers. The highest is in the layer 5 (80%: 400/501) and the lowest is in the bottom layer 10 (only 10%; **Table 4.9.1**).

The main raw material of the flake fragments is the grey sandstone representing around 90% (2777/3081). This is quite constant, except in the bottom layer 10 (57%: 23/40).

The other raw materials like quartz, siliceous shale and mudstone are rare, but the black sandstone reaches nearly 10%, and mostly occurs in the bottom layer 10 (23%: 9/40) where the raw materials are more diversified, as already noted for several artefact categories (**Table 4.9.2**).

2) Small amorphous fragments:

The groups of the small fragments are amorphous pieces of rock or could not be identified as flake fragments. Their proportions strongly vary among the layers and are the highest in the layer 10 (90%: 357/397) and the lowest is in the layer 5 (9%: 46/501; **Table 4.9.1**).

The common grey sandstone is representing 83% (3344/4008) of the amorphous small fragments, and is especially dominant in the layer 7 (97%: 308/317). The other raw materials are scarcely represented, except for the mudstone, remarkable in the layer 8 **(**24%; **Table 4.9.3)**.

2.1) Raw materials

Small sizes of fragments **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Gray sandstone**		**Black sandstone**		**Granite**		**Quartz**		**Quartzite**		**Mudstone**		**Siliceous shale**		**Zeolite**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**1482**	83	**224**	13	**4**		**27**	2	**20**	1	**25**	1	**3**		**3**		**1788**
Layer 4 (340-700 cm dt.)	**577**	85	**41**	6	**0**		**4**		**26**	4	**28**	4	**1**		**0**		**677**
Layer 5 (400-470 cm dt.)	**39**	85	**7**	15	**0**		**0**		**0**		**0**		**0**		**0**		**46**
Layer 6 (470-520 cm dt.)	**56**	86	**8**	12	**0**		**1**		**0**		**0**		**0**		**0**		**65**
Layer 7 (520- 580 cm dt.)	**308**	97	**7**	2	**0**		**2**		**0**		**0**		**0**		**0**		**317**
Layer 8 (580-720 cm dt.)	**369**	69	**17**	3	**2**		**2**		**16**	3	**125**	24	**1**		**0**		**532**
Layer 9 (620-740 cm dt.)	**194**	86	**19**	8	**0**		**4**		**4**		**5**	2	**0**		**0**		**226**
Layer 10 (700-780 cm dt.)	**319**	89	**17**	5	**0**		**1**		**5**	2	**15**	4	**0**		**0**		**357**
Total	**3344**	83	**340**	9	**6**	0	**41**	1	**71**	2	**198**	5	**5**	0	**3**		**4008**

Table 4.9.3 The raw materials of small amorphous fragments from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

4.10 Analysis of unmodified manuports (pebbles & cobbles) from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

1) General features of the unmodified manuports (pebbles & cobbles)

Around 3% of the studied material (276 items) are unmodified manuports (pebbles & cobbles) in the stratigraphic layers 3 to 10 of area 2, sectors S20W10 and S21W10. Their frequency seems to be slightly more in the lower layers, at least layers 10 and 9, than in the upper layers **(Tables 4.2.2, 4.10.1)**.

Unmodified manuports	**Layer 2**		**Layer 3**		**Layer 4**		**Layer 5**		**Layer 6**		**Layer 7**		**Layer 8**		**Layer 9**		**Layer 10**		**Total**
Numbers (%)	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
S20W10 (SEQ 3-4)	**0**		**62**	2	**32**	2	**0**		**0**		**0**		**20**	2	**6**	2	**21**	4	**141**
S21W10 (SEQ 3-4)	**9**	2	**2**		**16**	4	**11**	1	**11**	5	**49**	4	**10**	3	**32**	7	**4**	50	**144**
S21W10 (SEQ 1-2)	**-**		**-**		**-**		**20**	6	**17**	3	**5**	7	**-**		**-**		**-**		**42**
S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)			**64**	2	**48**	2	**11**	1	**11**	5	**49**	4	**30**	2	**38**	5	**25**	5	**276** (3%)
Lithic Artefacts S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)			**3611**		**2266**		**689**		**232**		**1258**		**1371**		**789**		**524**		**10740**

Table 4.10.1 Total number of unmodified manuports (pebbles & cobbles) in the stratigraphic sequence of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4), S21W10 (SEQ 3-4) and S21W10 (SEQ 1-2)

Raw materials S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Gray sandstone**		**Black sandstone**		**Red sandstone**		**Quartz**		**Quart-zite**		**Mudstone**		**Granite**		**Zeolite**		**Total**
Layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3	**54**	84	**0**		**0**		**2**		**2**		**4**		**1**		**1**		**64**
Layer 4	**40**	83	**2**		**0**		**1**		**4**		**1**		**0**		**0**		**48**
Layer 5	**9**	82	**1**		**1**		**0**		**0**		**0**		**0**		**0**		**11**
Layer 6	**10**	91	**1**		**0**		**0**		**0**		**0**		**0**		**0**		**11**
Layer 7	**40**	82	**4**		**0**		**2**		**3**		**0**		**0**		**0**		**49**
Layer 8	**26**	87	**3**		**0**		**0**		**1**		**0**		**0**		**0**		**30**
Layer 9	**36**	95	**1**		**0**		**0**		**1**		**0**		**0**		**0**		**38**
Layer 10	**22**	88	**0**		**0**		**0**		**0**		**3**		**0**		**0**		**25**
Total	**237**	86	**12**	4	**1**		**5**	2	**11**	4	**8**	3	**1**		**1**		**276**

Table 4.10.2 The raw materials of unmodified manuports (pebbles & cobbles) from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Their raw materials are the same as usual, mostly comprised of gray sandstone: 86% (237/276). The other raw materials are and are very rare in these sectors (less than 5% each), but quartz and quartzite are slightly more frequent than among the choppers, for instance **(Table 4.10.2)**.

2) Measurements

Measurement **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Length (mm)**	**Width (mm)**	**Thickness (mm)**	**Number of manuports**
Layer 3 (320-640 cm dt.)	108	75	48	64
Layer 4 (340-700 cm dt.)	104	76	50	48
Layer 5 (400-470 cm dt.)	109	74	52	11
Layer 6 (470-520 cm dt.)	139	90	58	11
Layer 7 (520-580 cm dt.)	105	77	53	49
Layer 8 (580-720 cm dt.)	83	56	34	30
Layer 9 (620-740 cm dt.)	102	88	63	38
Layer 10 (700-780 cm dt.)	90	61	39	25
Average	**106**	**75**	**50**	**276**

Table 4.10.3 Average dimensions of the unmodified manuports from area, 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The average dimensions of the unmodified manuports (pebbles & cobbles) is fluctuating between 139 and 83 mm for the length and between 90 and 61 mm for the width. The biggest unmodified manuports are in the layer 6 (139 x 90 mm) and the smallest in the layer 8 (83 x 56 mm). The average thickness is of 50 mm in general, but most of the values are between 48 and 63 mm, except in the layers 8 and 10 where the specimens are thinner (34 and 39 mm; **Table 4.10.3, figures 4.10.4 & 4.10.5)**

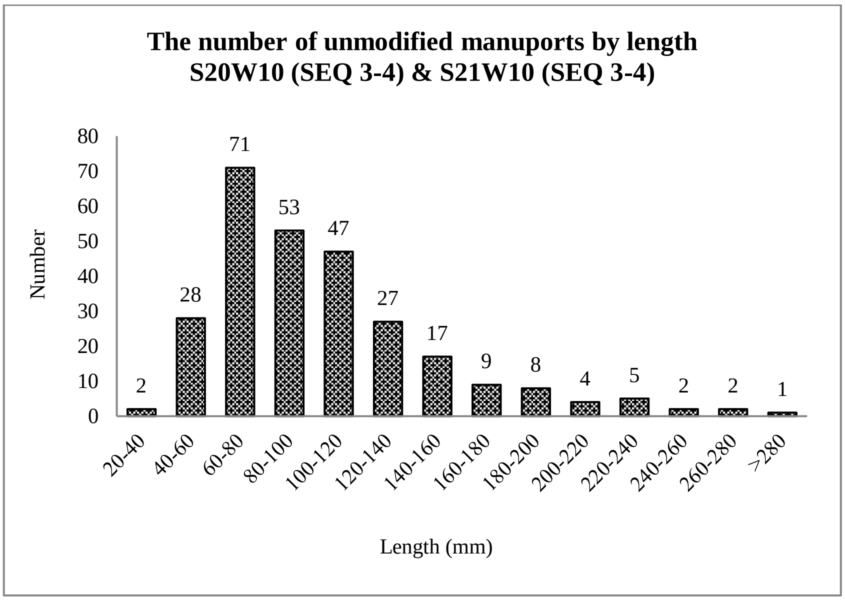


Figure 4.10.1 Distribution of the number unmodified manuports (pebbles & cobbles) by length from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

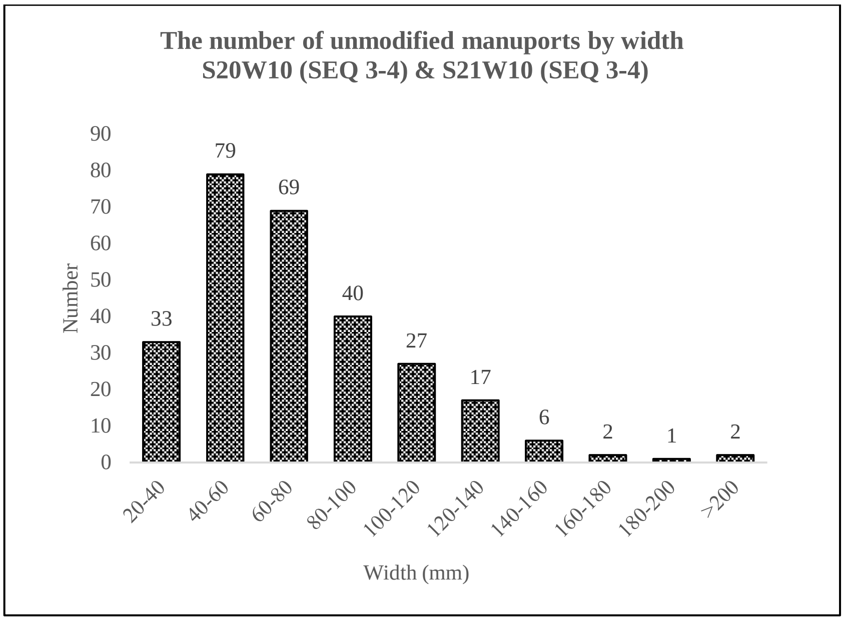


Figure 4.10.2 Distribution of the number unmodified manuports (pebbles & cobbles) by width from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

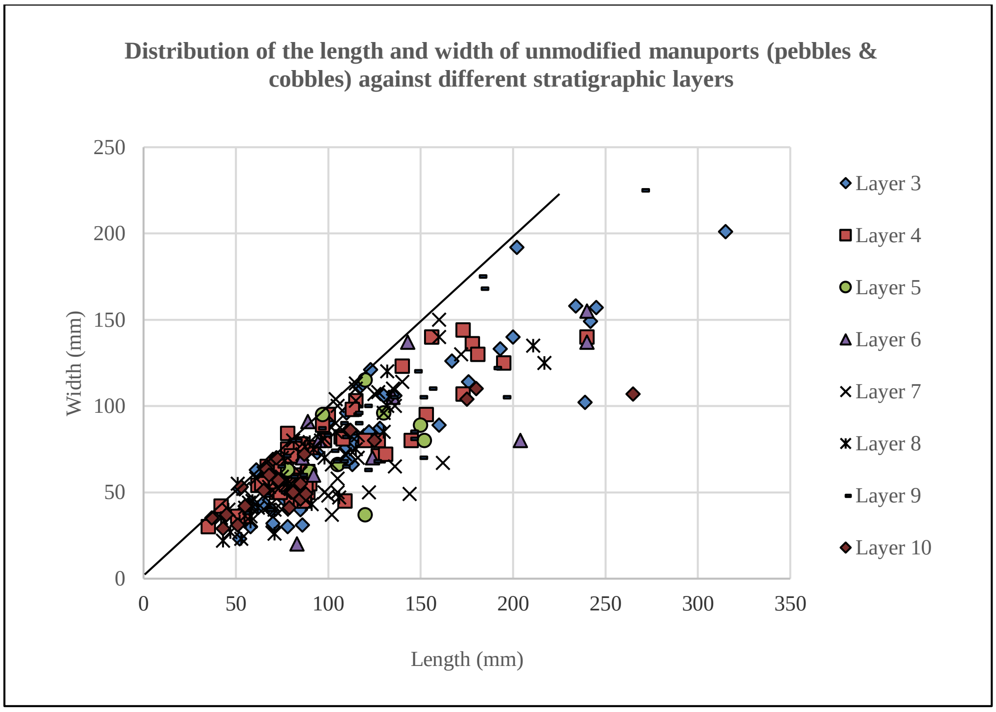


Figure 4.10.3 Scatter diagram length x width of the unmodified manuports (pebbles & cobbles) from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

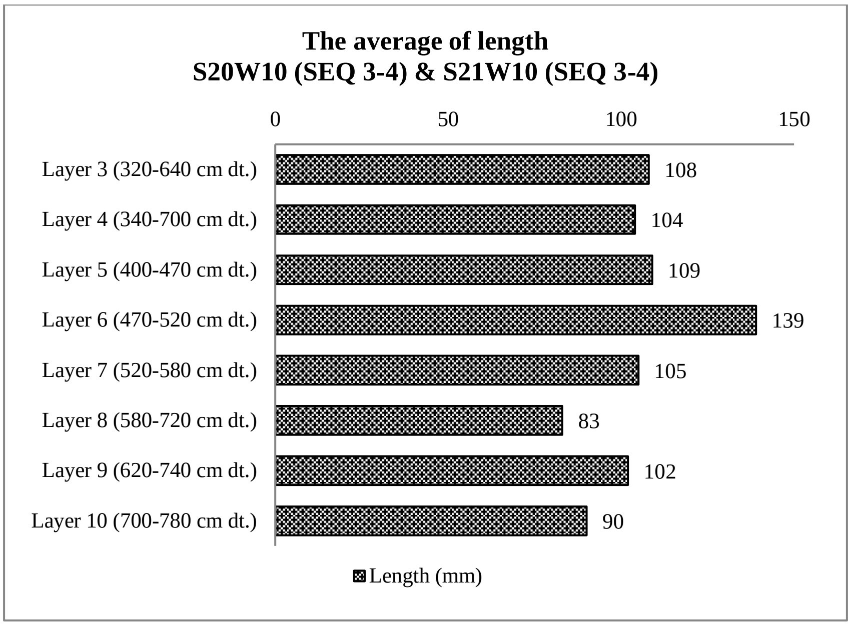


Figure 4.10.4 Distribution of the average length of the unmodified manuports (pebbles & cobbles) across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

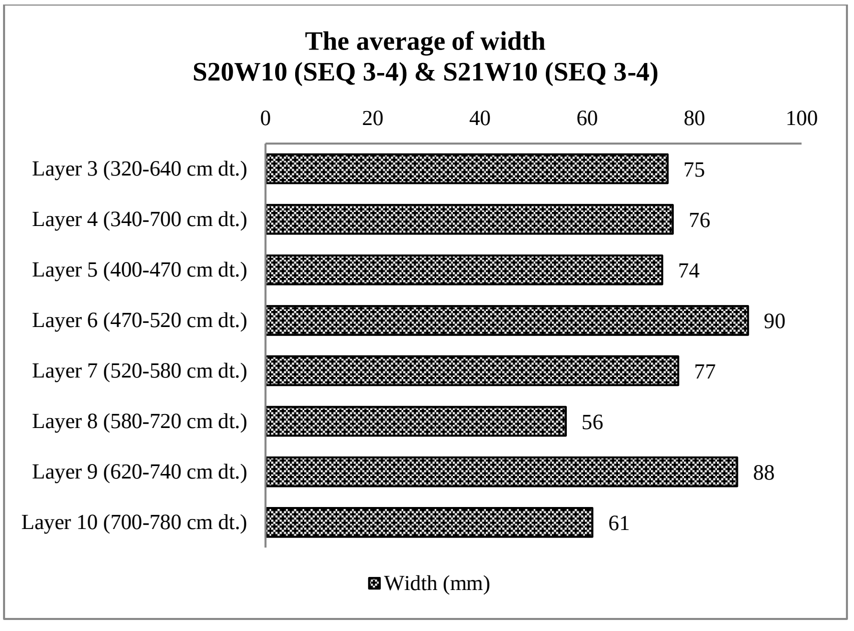


Figure 4.10.5 Distribution of the average width of the unmodified manuports (pebbles & cobbles) across the stratigraphy of Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Weight (gr.) **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**<200**	**201-400**	**401-600**	**601-800**	**801-1000**	**1001-1200**	**1201-1400**	**1401-1600**	**1601-1800**	**1801-2000**	**>2000**	**Total**
Layer 3 (320-640 cm dt.)	28	11	5	3	1	1	1	0	1	1	12	**64**
Layer 4 (340-700 cm dt.)	11	13	4	6	2	1	2	0	2	1	6	**48**
Layer 5 (400-470 cm dt.)	2	3	2	1	0	0	0	2	0	0	1	**11**
Layer 6 (470-520 cm dt.)	0	2	4	1	0	0	1	0	0	0	3	**11**
Layer 7 (520-580 cm dt.)	8	19	7	1	2	1	4	1	2	1	3	**49**
Layer 8 (580-720 cm dt.)	19	2	4	2	0	0	0	1	0	0	2	**30**
Layer 9 (620-740 cm dt.)	4	4	8	6	3	4	2	1	0	0	6	**38**
Layer 10 (700-780 cm dt.)	14	5	2	1	0	0	1	0	0	0	2	**25**
Total	**86**	**59**	**36**	**21**	**8**	**7**	**11**	**5**	**5**	**3**	**35**	**276**

Table 4.10.4 The weight (in gram) of unmodified manuports (pebbles & cobbles) from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

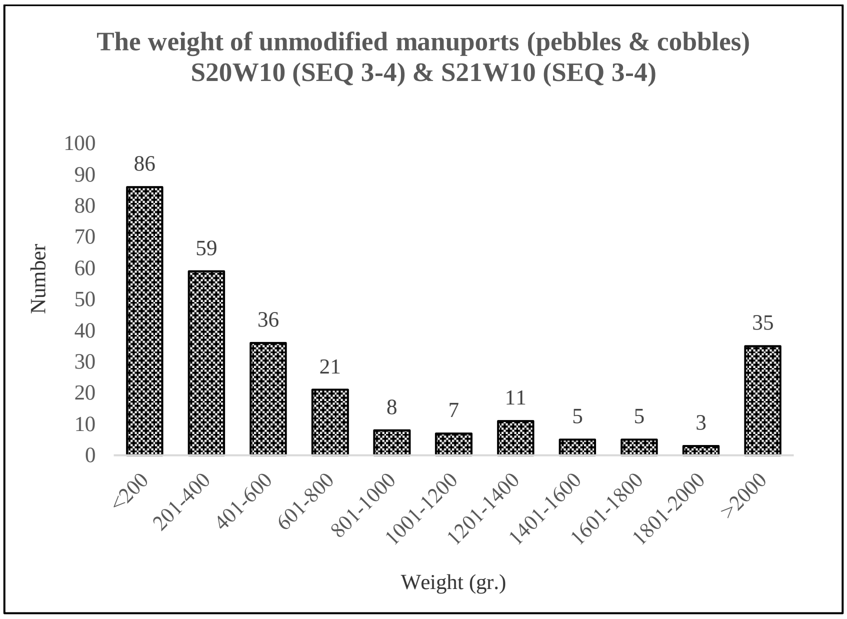


Figure 4.10.6 Distribution of the weight (in gram) of unmodified manuports (pebbles & cobbles) from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The weight of unmodified manuports (pebbles & cobbles) ranges between less than 200 g and more than 2000 g. Most of the weigh between less than 200 and 600 g (181 tools: 65% in the whole sequence), significantly in the upper and the lower layers **(Table 4.10.4, figure 4.10.6)**.

Therefore the unmodified manuports are bigger and heavier than the hammerstones while they are smaller and lighter than the choppers.

3) Type of unmodified manuports (pebbles & cobbles)

Type of unmodified manuports **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Cobble**		**Broken cobble**		**Pebble**		**Broken pebble**		**Boulder**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**29**	45	**25**	39	**6**	9	**3**		**1**		**64**
Layer 4 (340-700 cm dt.)	**16**	33	**22**	46	**4**		**6**	13	**0**		**48**
Layer 5 (400-470 cm dt.)	**5**	46	**4**		**1**		**1**		**0**		**11**
Layer 6 (470-520 cm dt.)	**5**	46	**5**	45	**0**		**1**		**0**		**11**
Layer 7 (520-580 cm dt.)	**25**	51	**21**	43	**1**		**2**		**0**		**49**
Layer 8 (580-720 cm dt.)	**13**	43	**3**		**9**	30	**5**	17	**0**		**30**
Layer 9 (620-740 cm dt.)	**16**	42	**20**	53	**0**		**2**		**0**		**38**
Layer 10 (700-780 cm dt.)	**8**	32	**7**	28	**8**	32	**2**		**0**		**25**
Total	**117**	42	**107**	39	**29**	11	**22**	8	**1**		**276**

Table 4.10.5 Types of unmodified manuports (pebbles & cobbles) from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

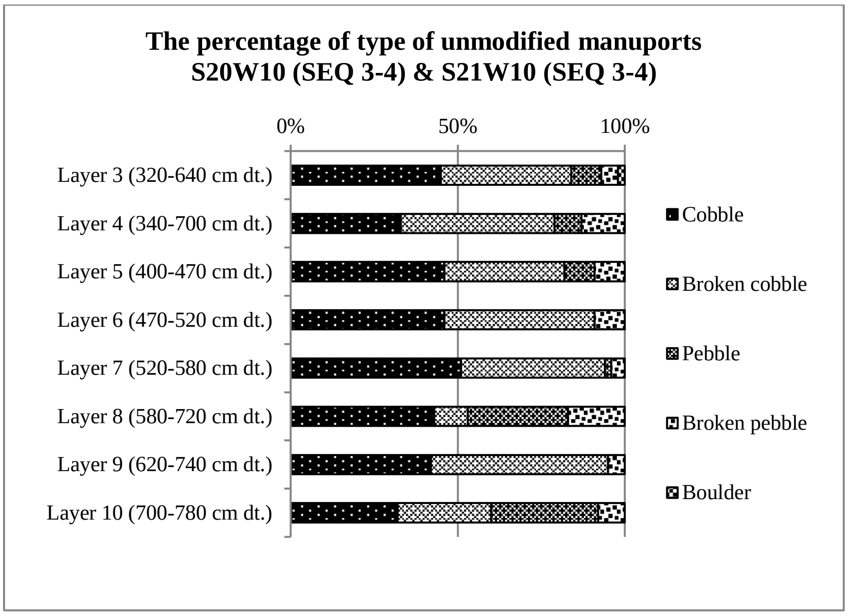


Figure 4.10.7 Distribution of the type of unmodified manuports (pebbles & cobbles) from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The unmodified manuports are mostly cobbles (42%:117/276) or broken cobbles (nearly 40%: 107/276), and there are no variations in the layers, except in the layer 8 where pebbles (< 64 mm) are almost as frequent as cobbles. The same tendency also occurs in the layer 10 **(Table 4.10.5, figure 4.10.7)**.

3.1) Type of fractures

Type of fractures S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Oblique**		**Perpendicular**		**Split**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**3**		**21**	75	**4**		**28**
Layer 4 (340-700 cm dt.)	**1**		**22**	81	**4**		**27**
Layer 5 (400-470 cm dt.)	**1**		**4**		**0**		**5**
Layer 6 (470-520 cm dt.)	**1**		**4**		**0**		**5**
Layer 7 (520-580 cm dt.)	**6**	27	**12**	55	**4**		**22**
Layer 8 (580-720 cm dt.)	**0**		**4**		**4**		**8**
Layer 9 (620-740 cm dt.)	**5**	28	**13**	72	**0**		**18**
Layer 10 (700-780 cm dt.)	**4**		**4**		**3**		**11**
Total	**21**	16	**84**	69	**19**	15	**124**

Table 4.10.6 Type of fracture of the unmodified manuports (pebbles & cobbles) from Tham Lod Rockshelter, area 2 sectors S21W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

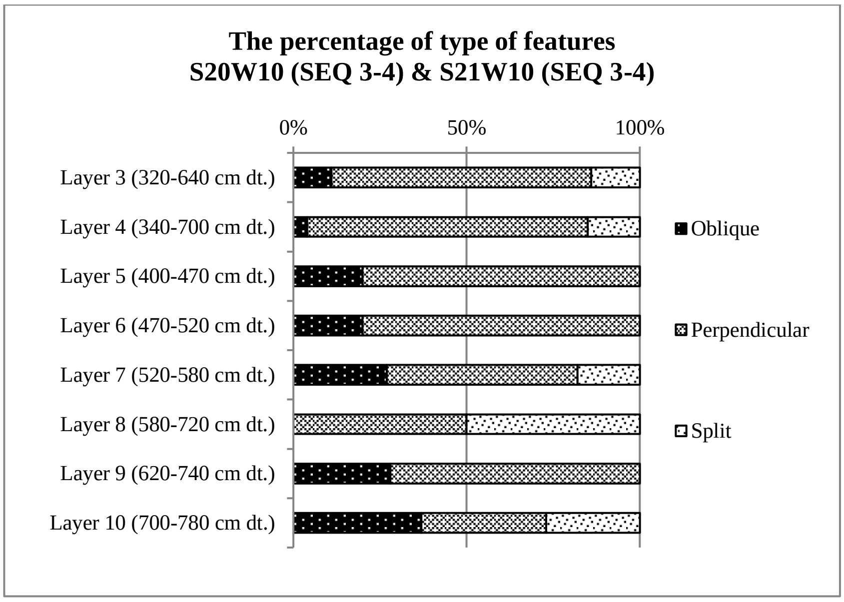


Figure 4.10.8 Distribution of the type of fracture on the unmodified manuports (pebbles & cobbles) from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

Fractures of the unmodified manuports are mostly perpendicular to the long axis (almost 70%: 84/124), except in the the layer 10, where oblique fractures are equally frequent (4/11) and split fractures almost so (3/11). In the other layers, the oblique and split fractures are much less frequent (15-16% of the studied material; **Table 4.10.6, figure 4.10.8**).

4) General morphology of unmodified manuports (pebbles & cobbles)

4.1) Frontal view

Frontal view S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)	**Oval**		**Irregular**		**Trapezoidal**		**Half-oval**		**Triangular**		**Circular**		**Pentagonal**		**D-shape**		**Concave-convex**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**22**	34	**11**	17	**17**	27	**2**		**2**		**1**		**5**	8	**3**		**1**		**64**
Layer 4 (340-700 cm dt.)	**13**	27	**8**	17	**13**	27	**7**	14	**2**		**2**		**2**		**0**		**1**		**48**
Layer 5 (400-470 cm dt.)	**5**	46	**1**		**1**		**3**		**0**		**1**		**0**		**0**		**0**		**11**
Layer 6 (470-520 cm dt.)	**2**		**5**	46	**0**		**4**		**0**		**0**		**0**		**0**		**0**		**11**
Layer 7 (520-580 cm dt.)	**13**	27	**9**	19	**7**	14	**13**	27	**2**		**2**		**1**		**1**		**1**		**49**
Layer 8 (580-720 cm dt.)	**10**	33	**7**	23	**6**	20	**4**		**3**		**0**		**0**		**0**		**0**		**30**
Layer 9 (620-740 cm dt.)	**11**	29	**11**	29	**2**		**8**	21	**3**		**1**		**0**		**1**		**1**		**38**
Layer 10 (700-780 cm dt.)	**13**	52	**5**	20	**3**		**1**		**0**		**2**		**0**		**1**		**0**		**25**
Total	**89**	32	**57**	21	**49**	18	**42**	15	**12**	4	**9**	3	**8**	3	**6**	2	**4**	4/276	**276**

Table 4.10.7 Frontal view of unmodified manuports (pebbles & cobbles) from Tham Lod Rockshelter, area 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

In the frontal view, the oval shape is more common than the other shapes (30%: 83/276) in accordance with the frequency of whole cobbles or pebbles, which may also be circular, or globally triangular or trapezoidal. Then irregular, trapezoidal and half-oval shapes represent around 25 to 15%. The other shapes are rare (less than 5%; **Table 4.10.7)**.

5) Location of fractures on the unmodified manuports (pebbles & cobbles)

Location of fractures **S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)**	**Right side**		**Left side**		**Distal site**		**Proximal side**		**Total**
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%	**N**
Layer 3 (320-640 cm dt.)	**15**	33	**12**	27	**14**	31	**4**		**45**
Layer 4 (340-700 cm dt.)	**11**	20	**8**	14	**24**	44	**12**	22	**55**
Layer 5 (400-470 cm dt.)	**0**		**1**		**5**	72	**1**		**7**
Layer 6 (470-520 cm dt.)	**1**		**1**		**5**	72	**0**		**7**
Layer 7 (520-580 cm dt.)	**8**	27	**7**	23	**13**	43	**2**		**30**
Layer 8 (580-720 cm dt.)	**1**		**4**		**6**	50	**1**		**12**
Layer 9 (620-740 cm dt.)	**7**	22	**5**	16	**16**	50	**4**	12	**32**
Layer 10 (700-780 cm dt.)	**5**	24	**7**	33	**7**	33	**2**		**21**
Total	**48**	23	**45**	22	**90**	43	**26**	12	**209**

Table 4.10.8 Location of fractures on the unmodified manuports (pebbles & cobbles) from Tham Lod Rockshelter, 2 sectors S20W10 (SEQ 3-4) & S21W10 (SEQ 3-4)

The location of fractures is noticeable on the distal side, for about 43% (90/209), followed by the right and left sides representing 23-22%. It is interesting to note that the proximal side is around 1/2 of the lateral sides **(Table 4.10.8)**.

6) Reddening/Burning of unmodified manuports (pebbles & cobbles)

Reddening/burning of unmodified manuports **S20W10 (SEQ 3-4)**	**Entirely**		**Cortex only**		**Some parts of cortex**		**Total**	
Stratigraphic layers	**N**	%	**N**	%	**N**	%	**N**	%
Layer 3 (540-640 cm dt.)	**0**		**1**		**0**		**1**	2
Layer 4 (640-700 cm dt.)	**2**		**0**		**1**		**3**	9
Layer 9 (720-740 cm dt.)	**1**		**0**		**0**		**1**	17
Layer 10 (740-780 cm dt.)	**1**		**0**		**0**		**1**	1/21
Total	**4**	3	**1**	1	**1**	1	**6**	4

Table 4.10.9 Reddening/burning marks on unmodified manuports (pebbles & cobbles) from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4)

Very few unmodified manuports have become red on totality or part of their surface, in the sector S20W10. This may be due to fir

Illustration of the lithic artefacts

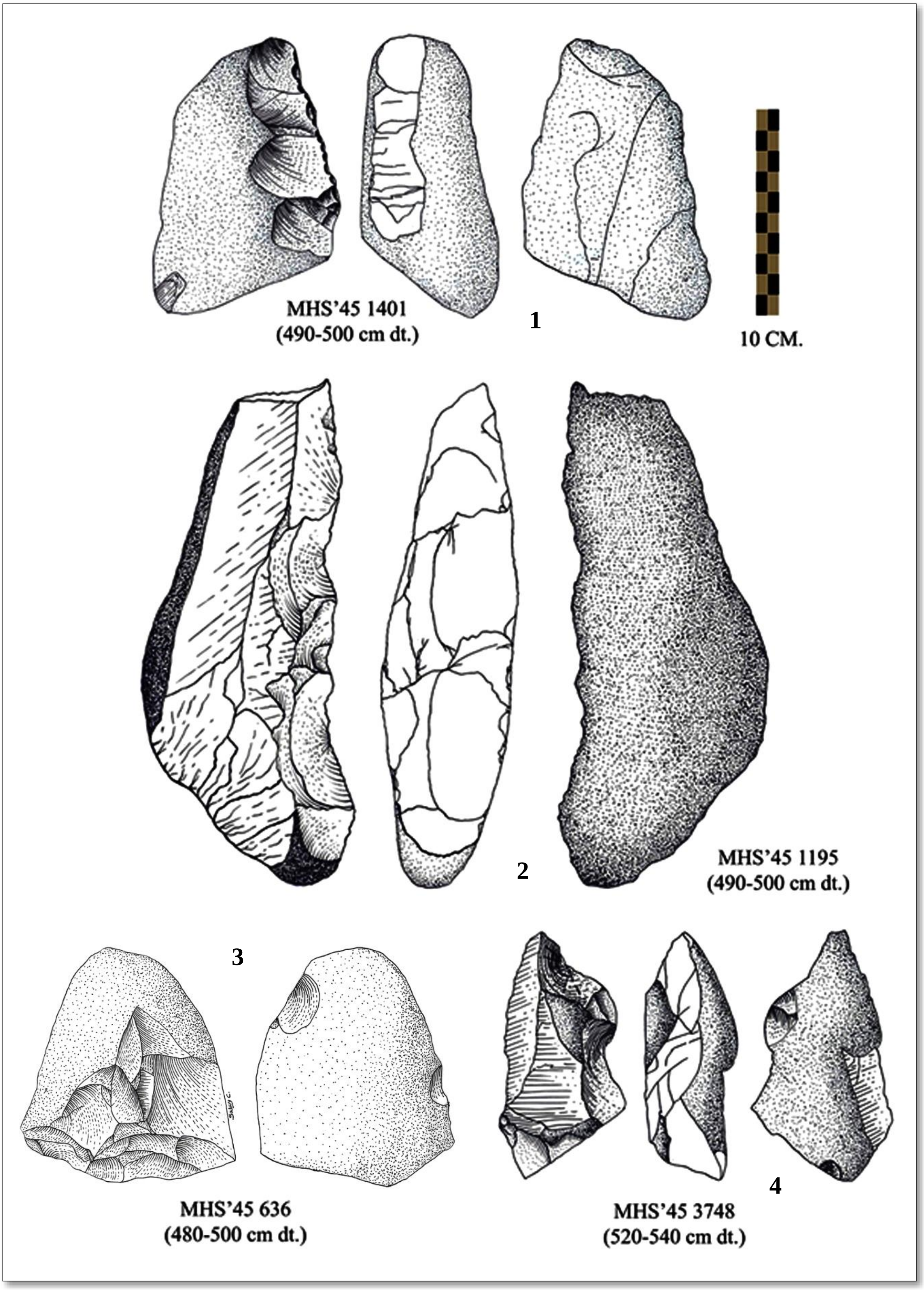


Plate 4.1 Large tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 2 (drawings T. Chitkament). 1) side chopper, 2) side chopper, 3) end chopper, 4) side chopper

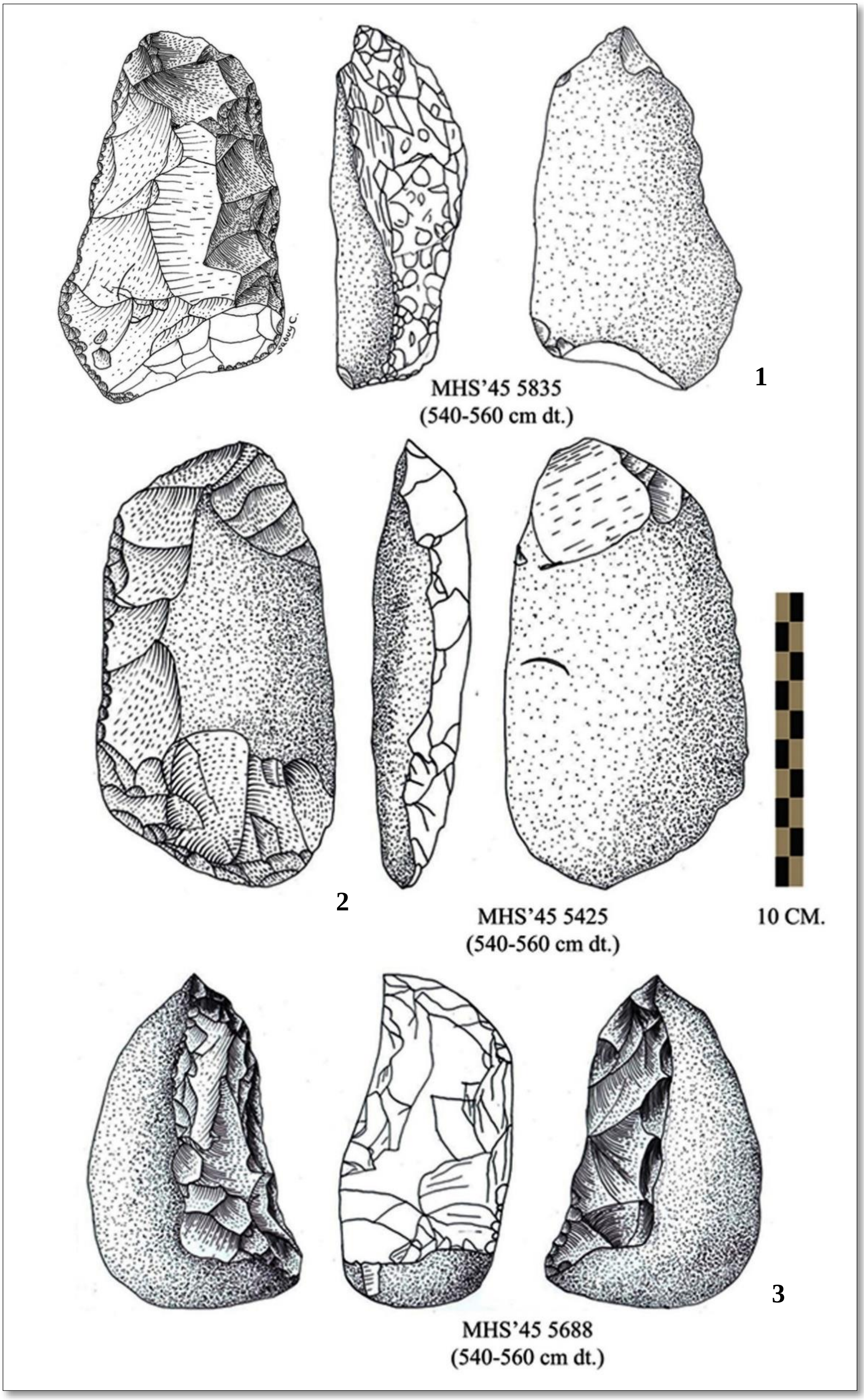


Plate 4.2 Large tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 3 (drawings T. Chitkament). 1) typical sumatralith, 2) partial sumatralith, 3) typical sumatralith

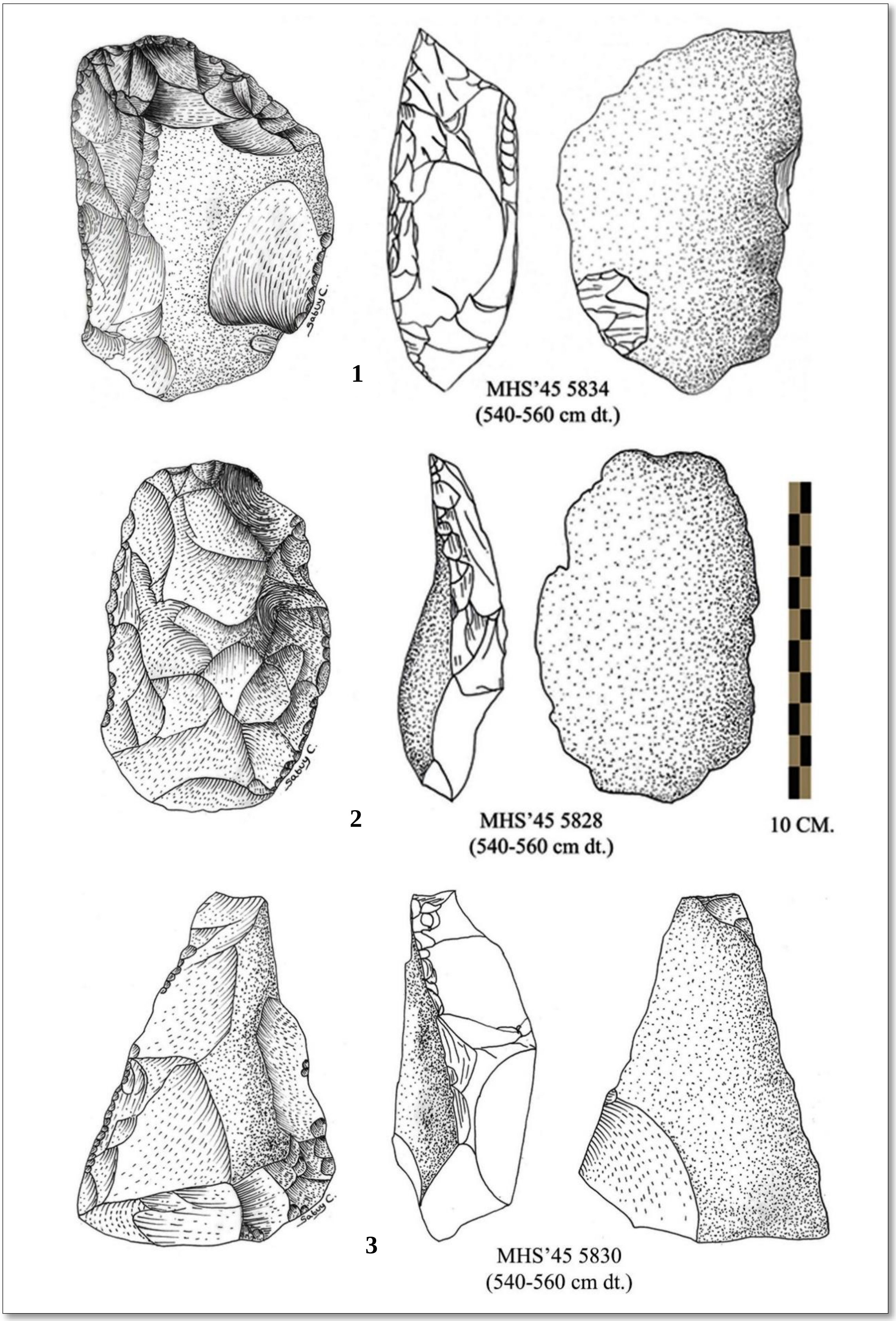


Plate 4.3 Large tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 3 (drawings T. Chitkament). 1) partial sumatralith, 2) typical sumatralith, 3) ½ sumatralith

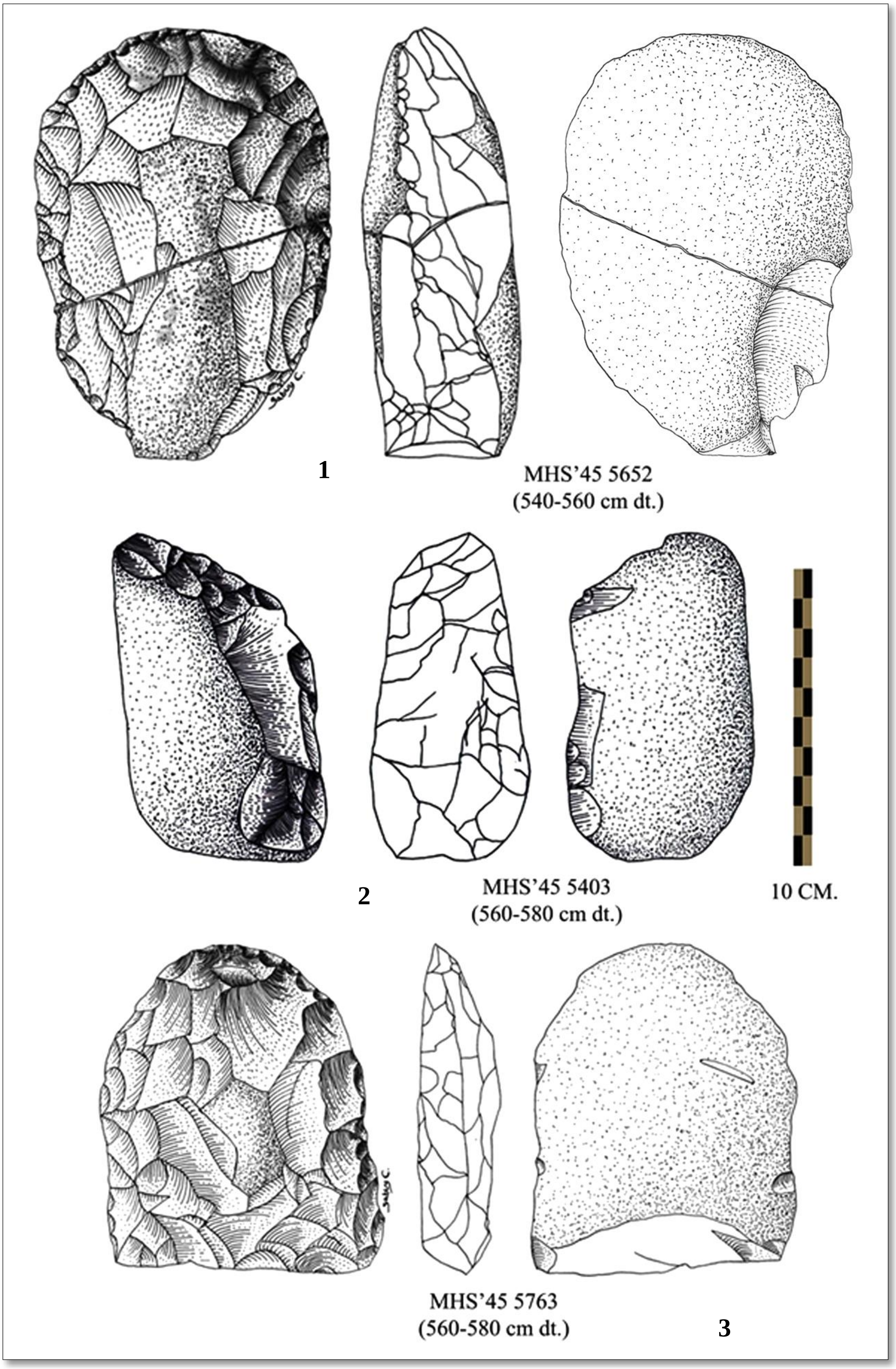


Plate 4.4 Large tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 3 (drawings T. Chitkament). 1) typical sumatralith, 2) partial sumatralith, 3) ¾ sumatralith

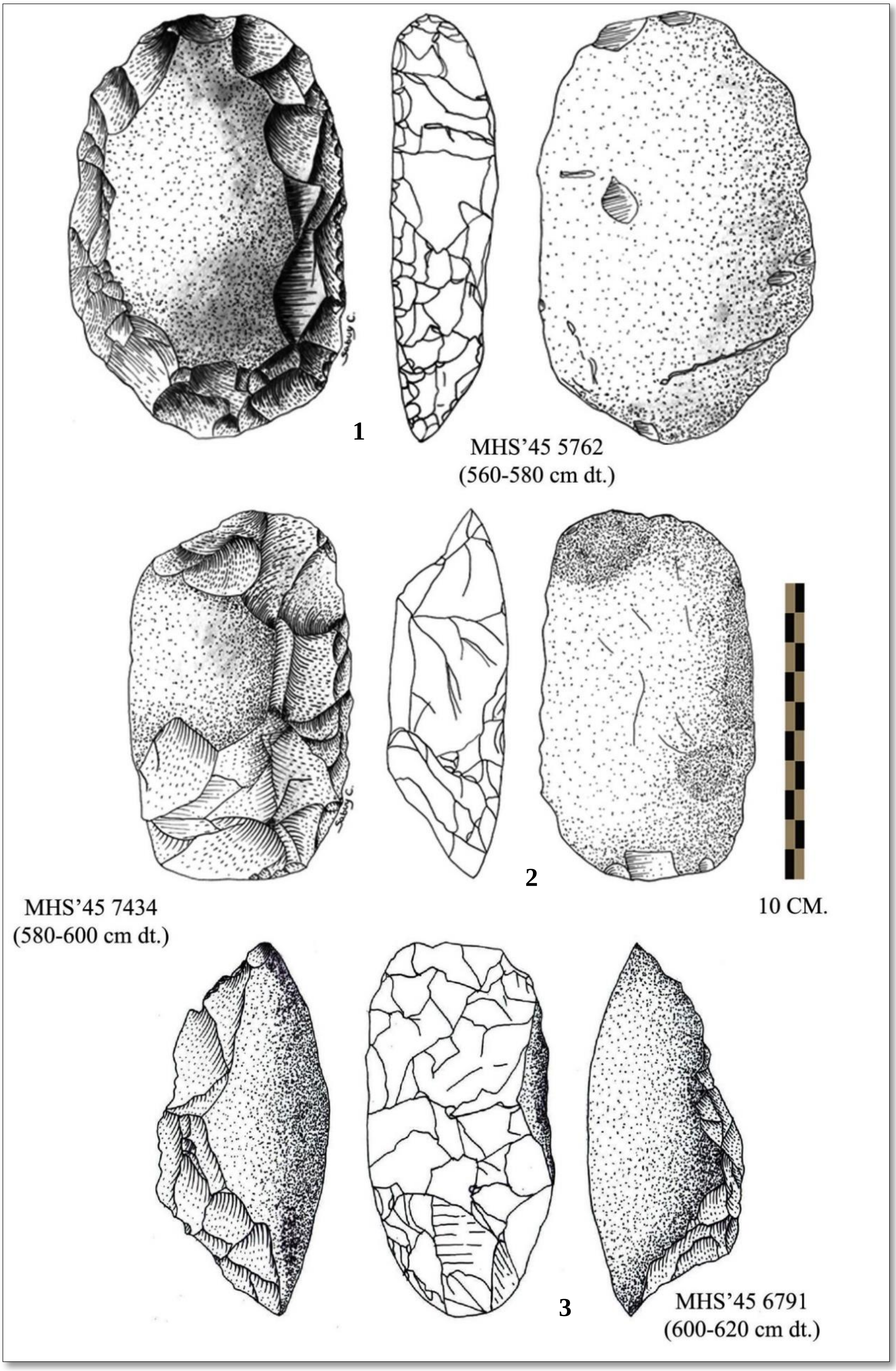


Plate 4.5 Large tools from Tham Lod Rockshelter , area 2 sector S20W10 (SEQ 3-4): layer 3 (drawings T. Chitkament). 1) typical sumatralith, 2 and 3) partial sumatraliths

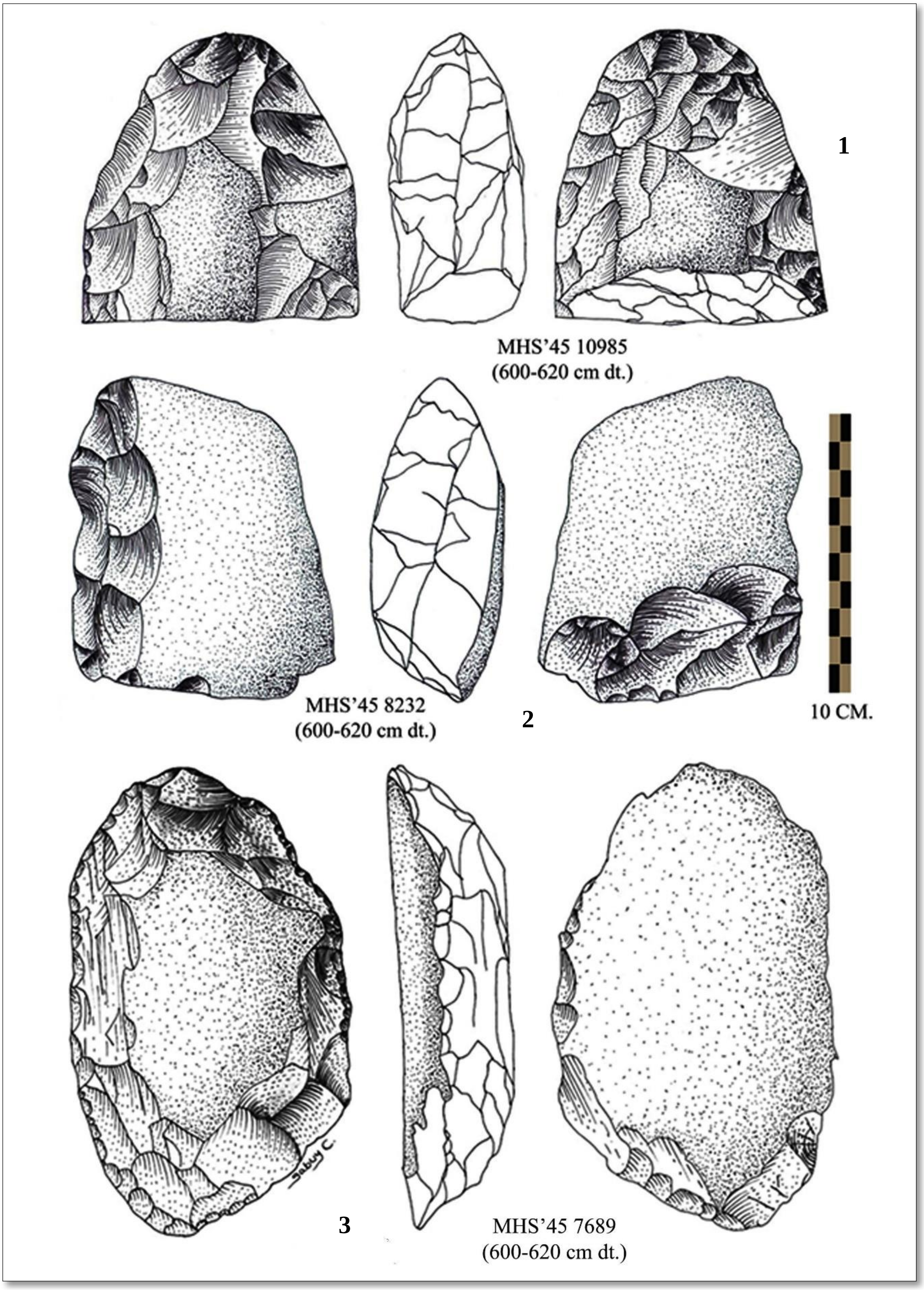


Plate 4.6 Large tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 3 (drawings T. Chitkament). 1) ½ sumatralith, 2) multiple chopper, 3) typical sumatralith

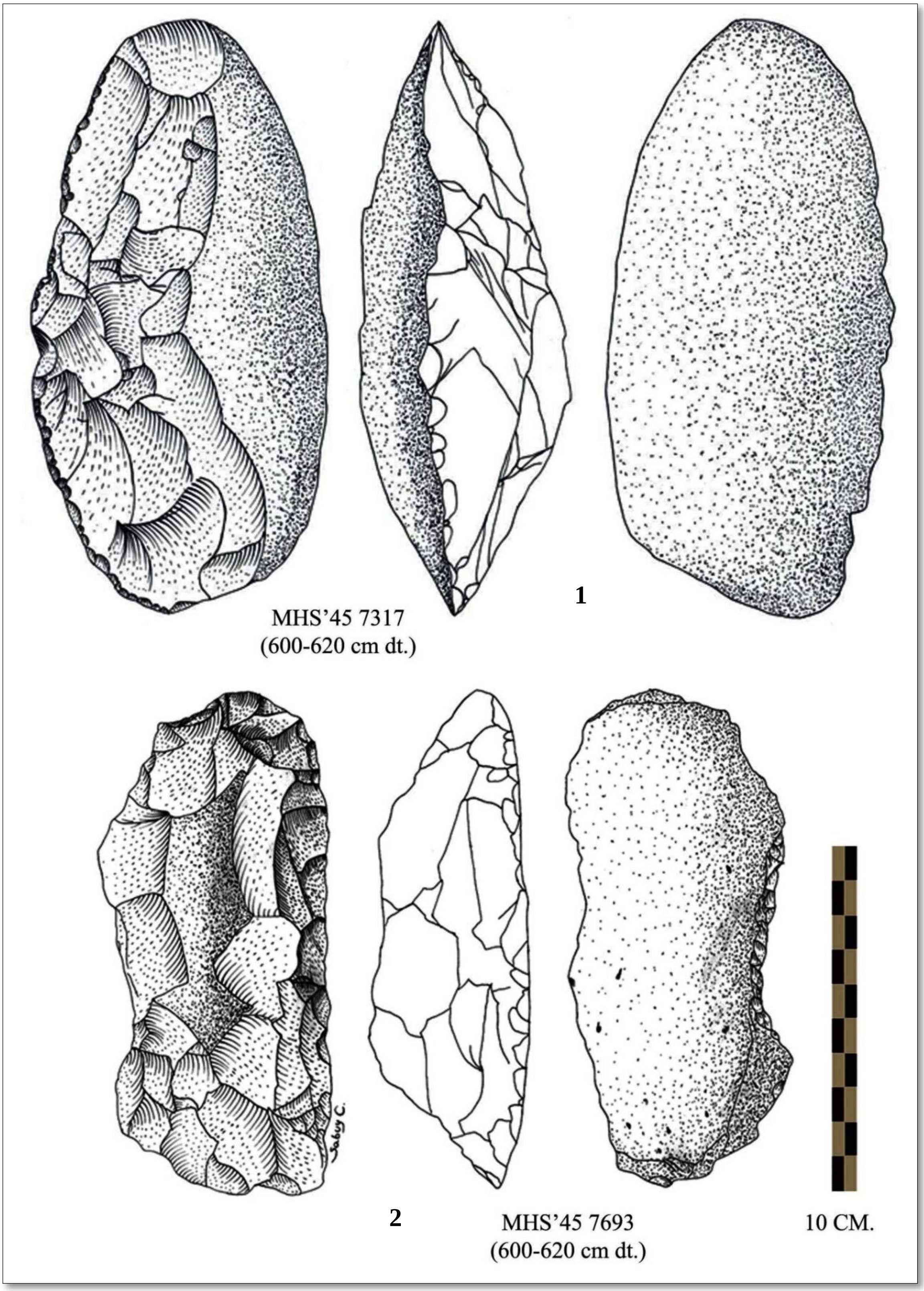


Plate 4.7 Large tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 3 (drawings T. Chitkament). 1) partial sumatralith, 2) typical sumatralith

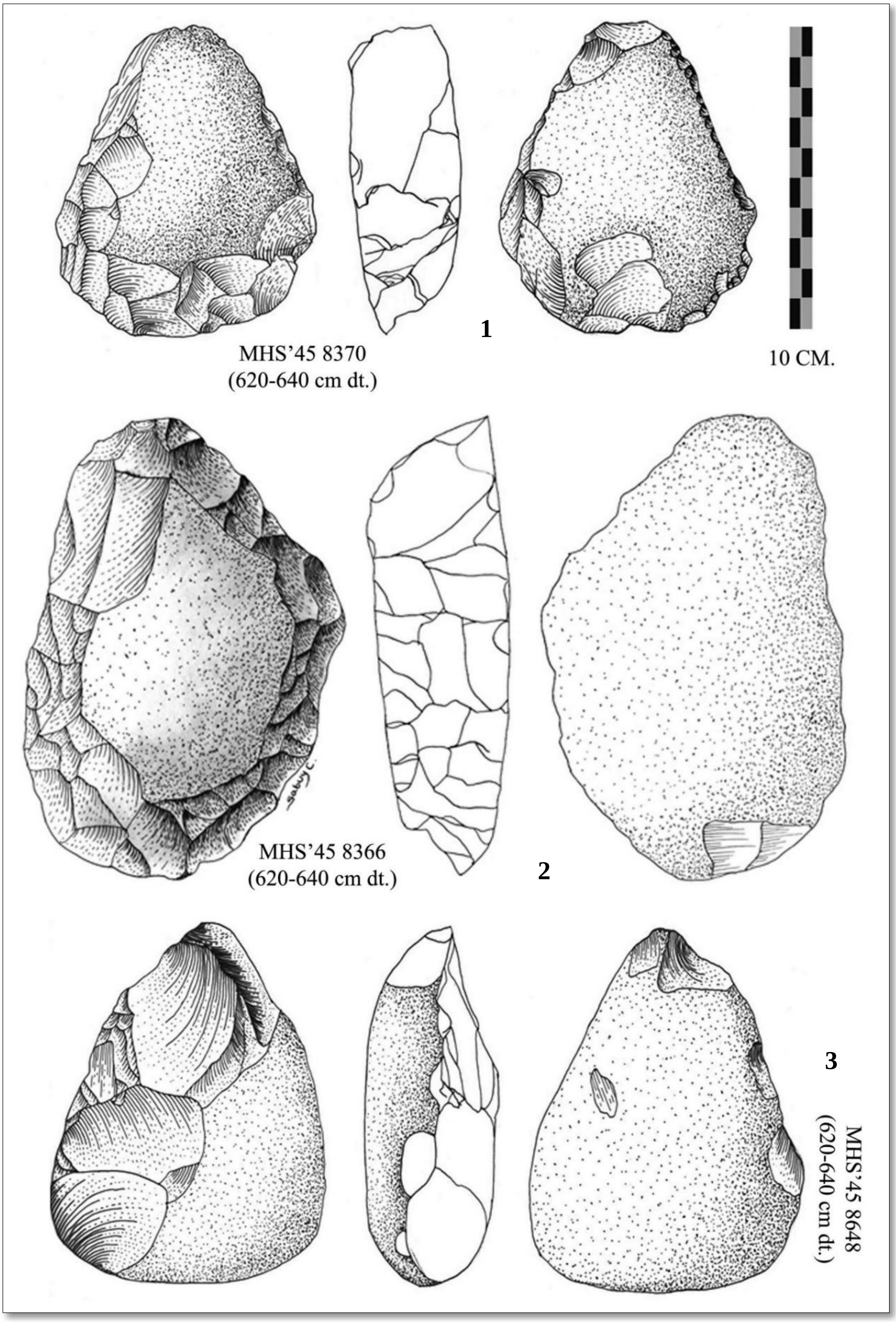


Plate 4.8 Large tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 3 (drawings T. Chitkament). 1) steep chopper, 2) typical sumatralith, 3) side chopper

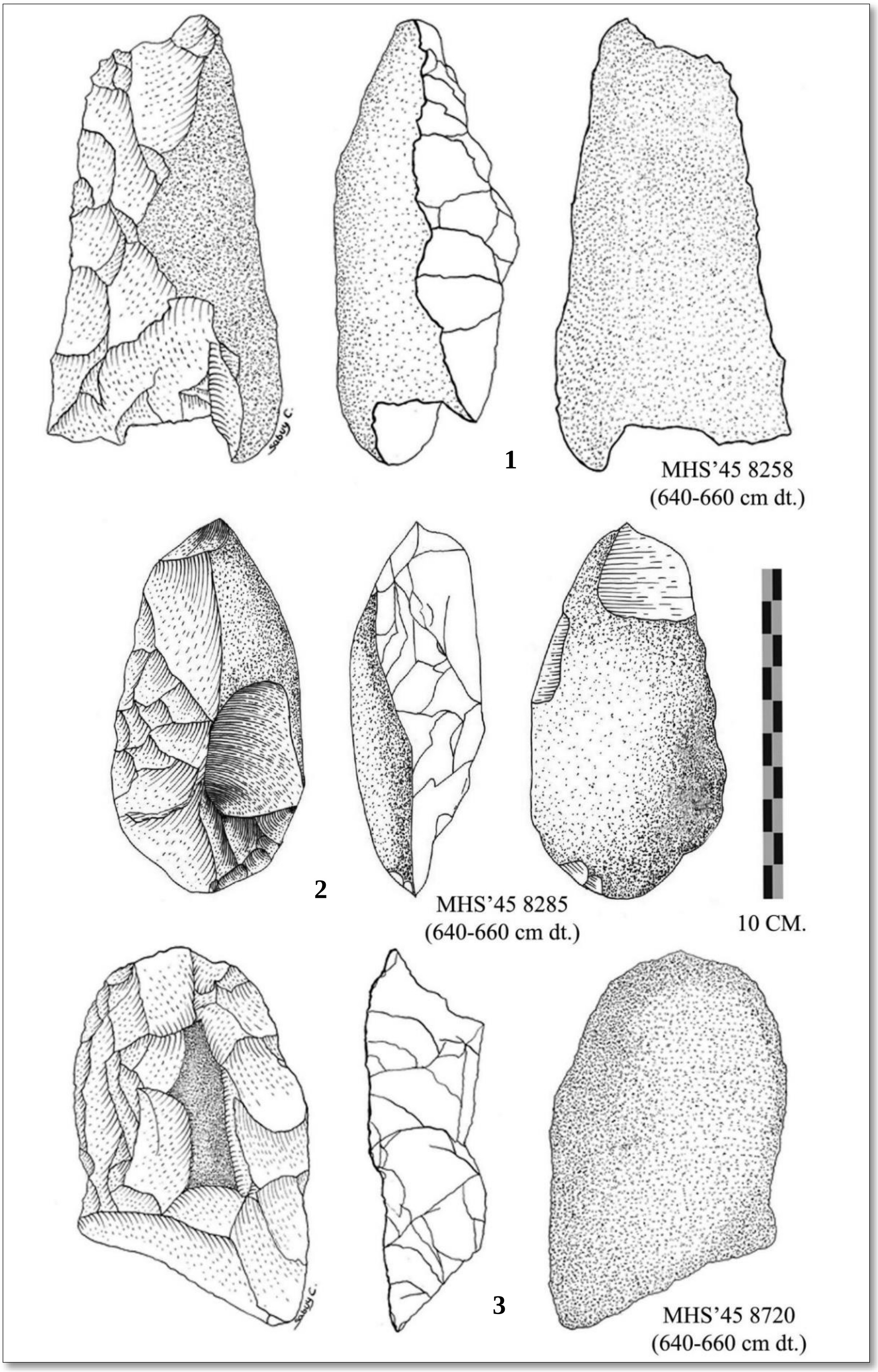


Plate 4.9 Large tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layers 3 and 4 (drawings T. Chitkament). 1 and 2) partial sumatraliths, 3) ¾ sumatralith

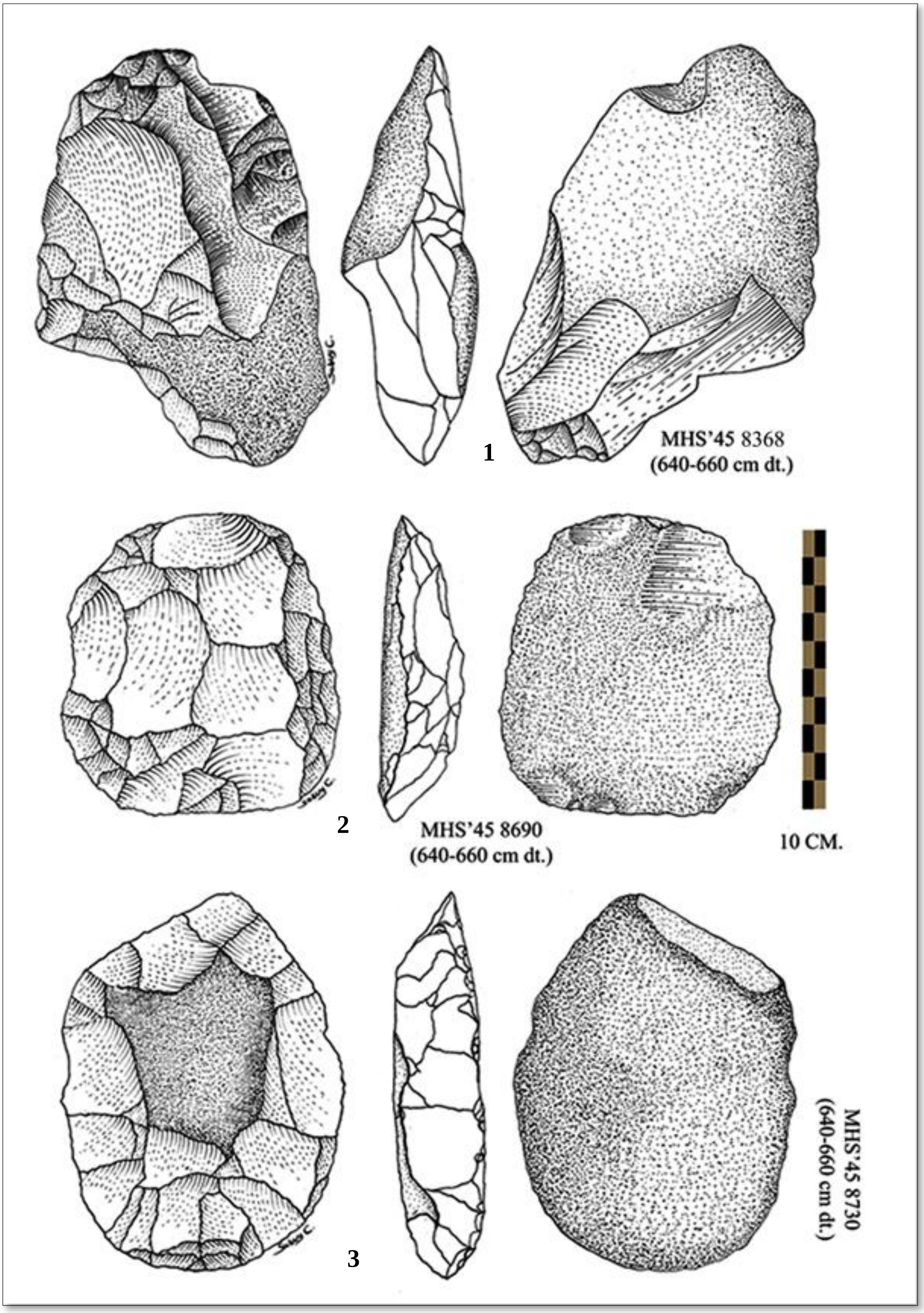


Plate 4.10 Large tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layers 3 and 4 (drawings T. Chitkament). 1) ½ bifacial tool, 2) unifacial discoid, 3) typical sumatralith

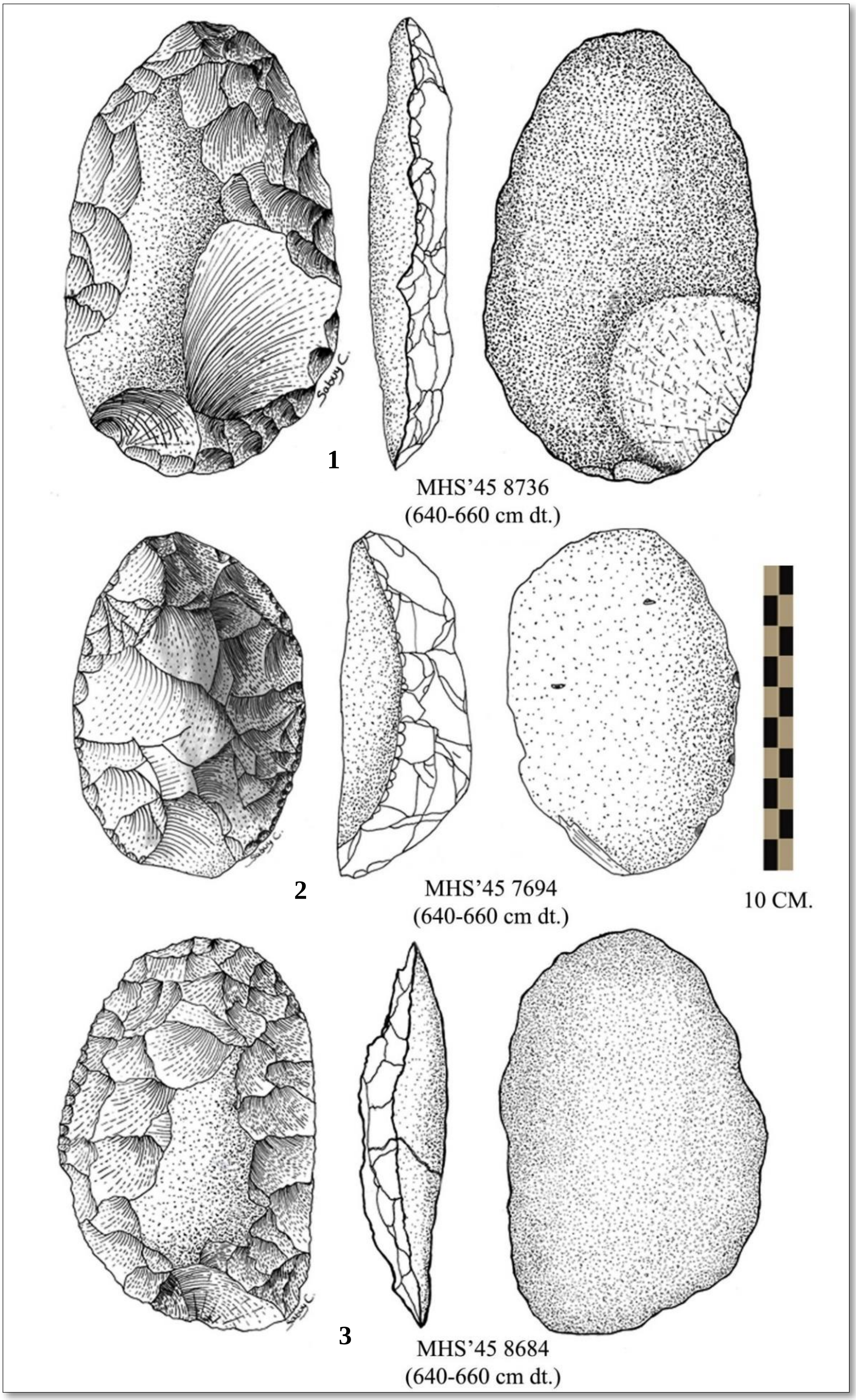


Plate 4.11 Large tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 4 (drawings T. Chitkament). 1, 2 and 3) typical sumatraliths

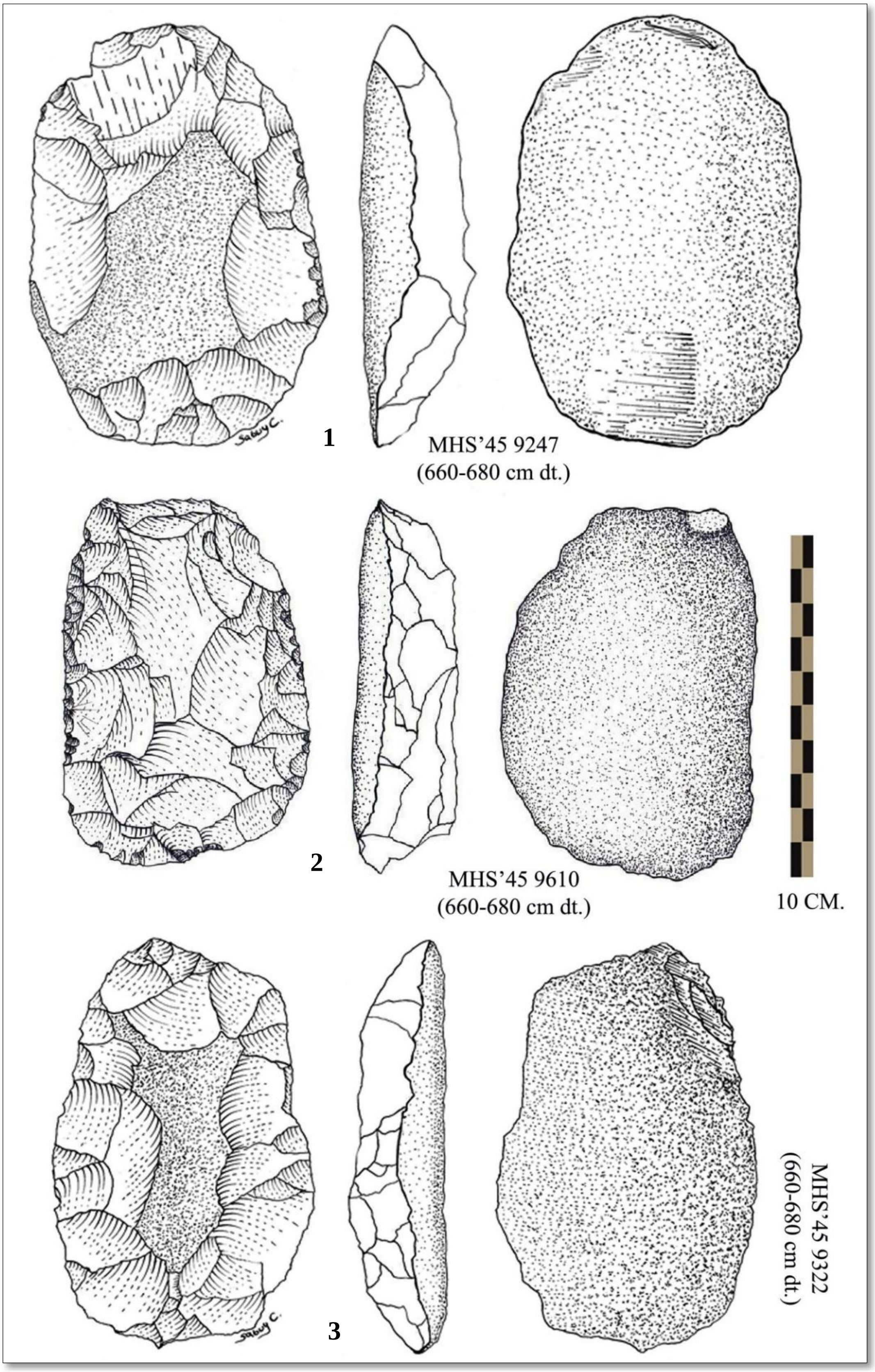


Plate 4.12 Large tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 4 (drawings T. Chitkament). 1, 2 and 3) typical sumatraliths

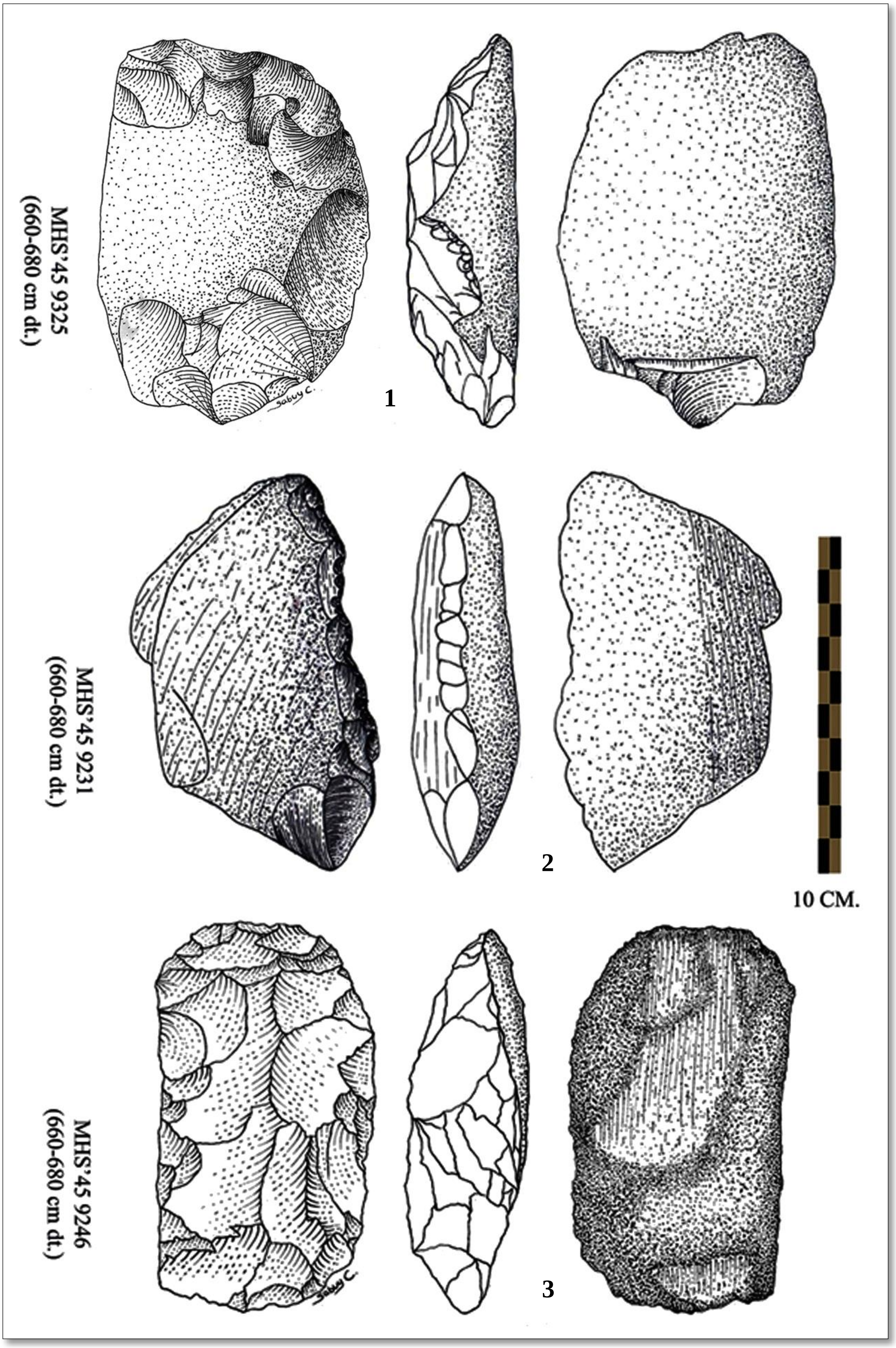


Plate 4.13 Large tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 4 (drawings T. Chitkament). 1) partial sumatralith, 2) side chopper, 3) typical sumatralith

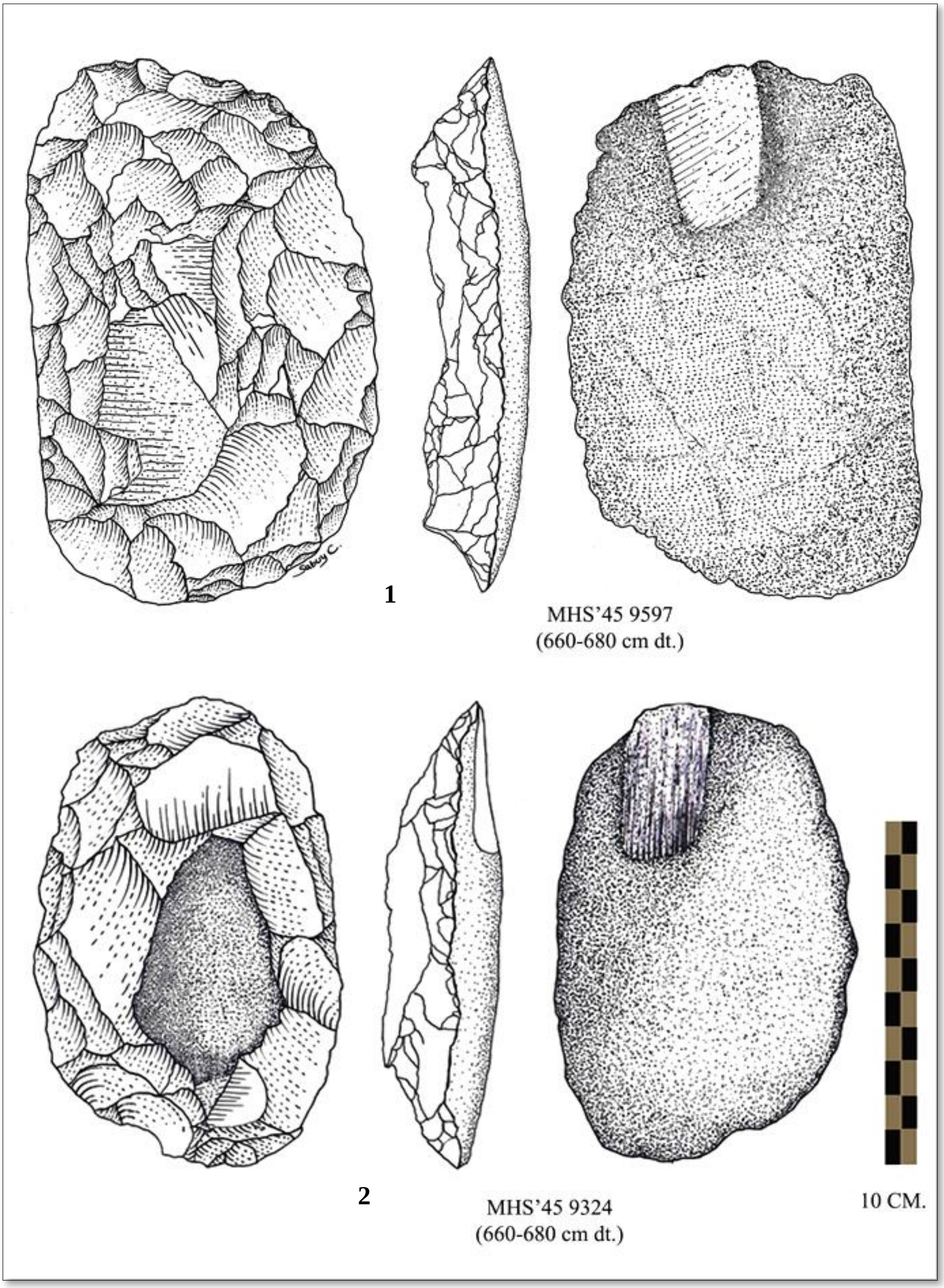


Plate 4.14 Large tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 4 (drawings T. Chitkament). 1) typical sumatralith, 2) typical sumatralith

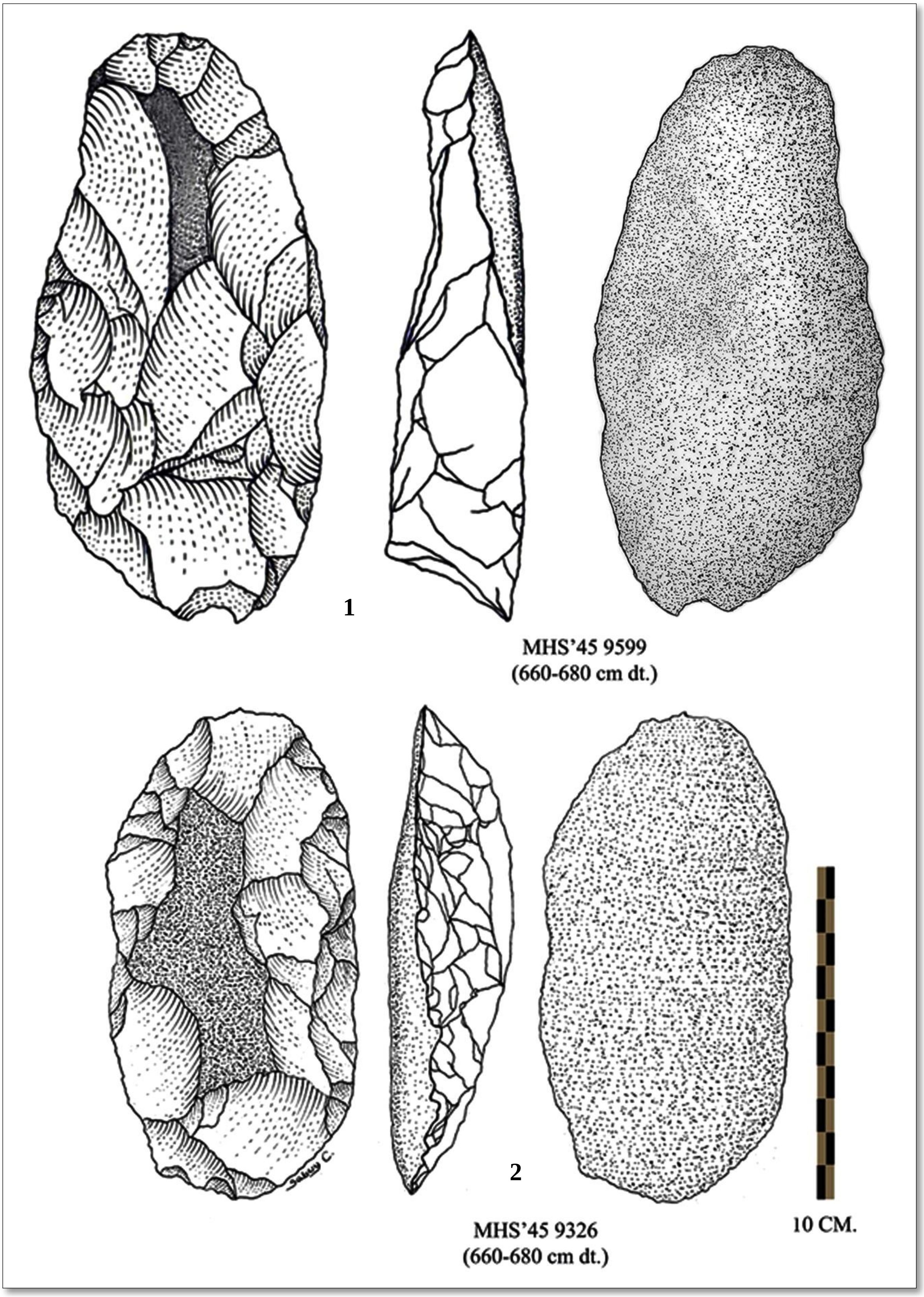


Plate 4.15 Large tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 4 (drawings T. Chitkament). 1 and 2) typical sumatraliths

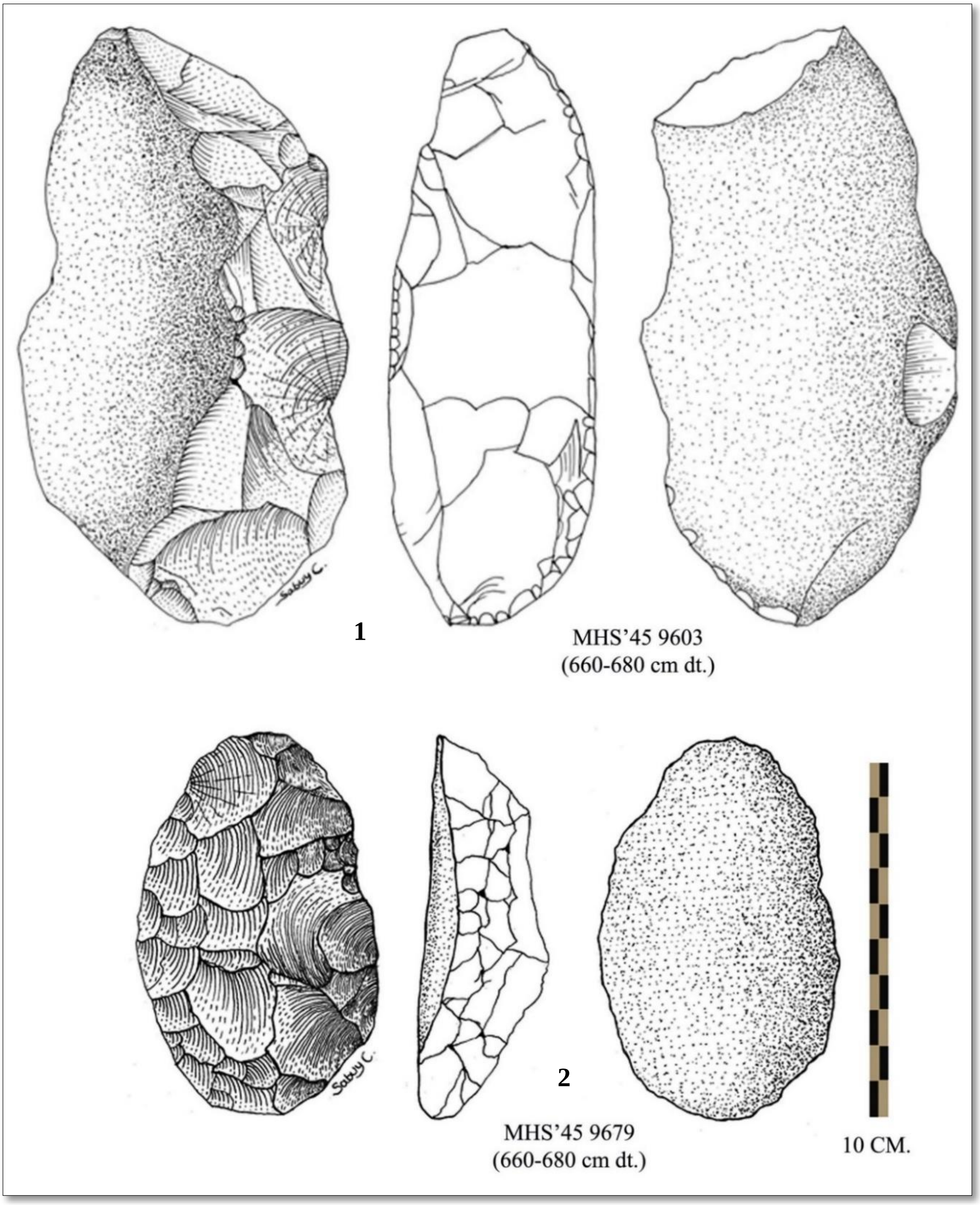


Plate 4.16 Large tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 4 (drawings T. Chitkament). 1) side chopper, 2) typical sumatralith

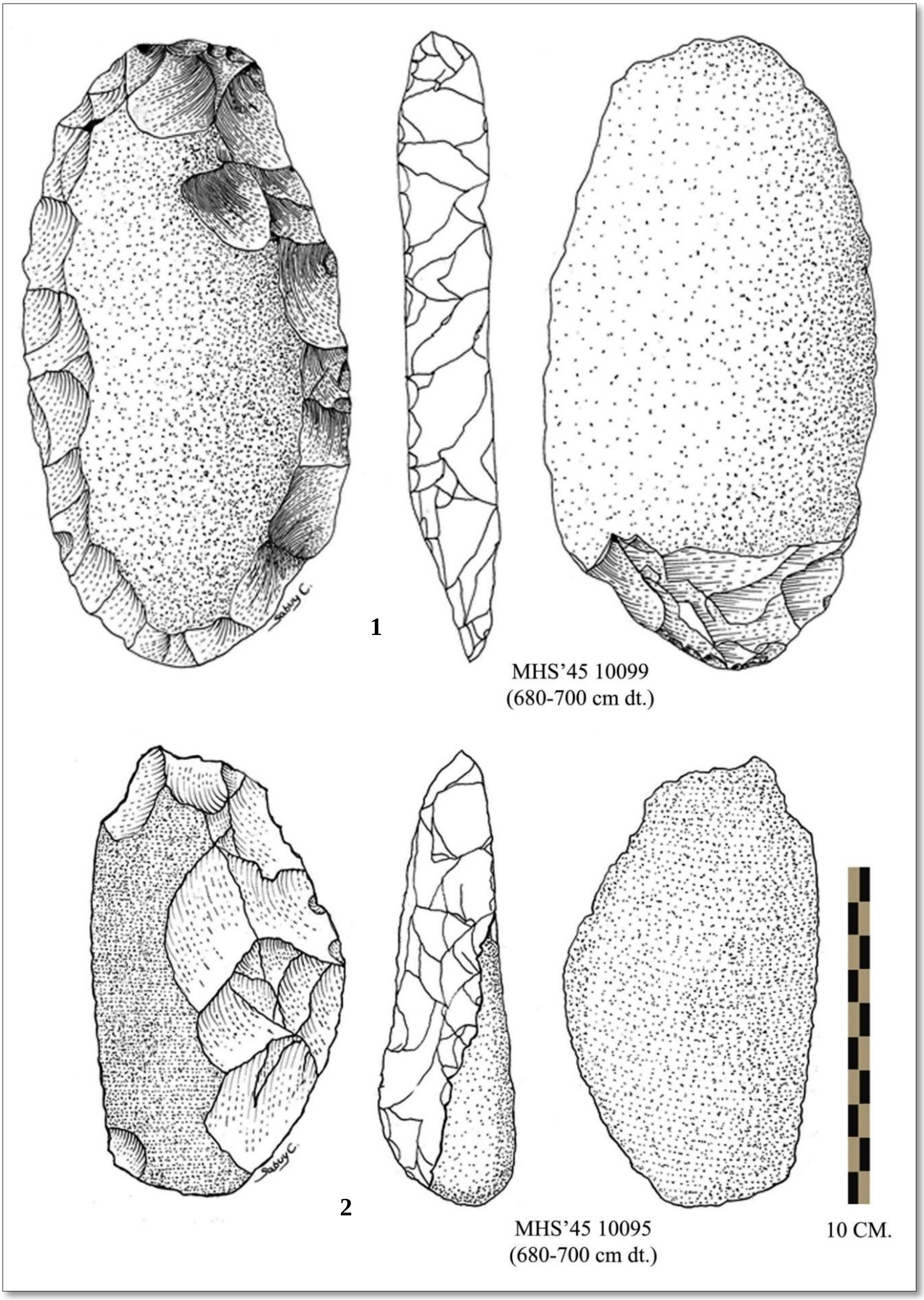


Plate 4.17 Large tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 4 (drawings T. Chitkament). 1) typical sumatralith, 2) partial sumatralith

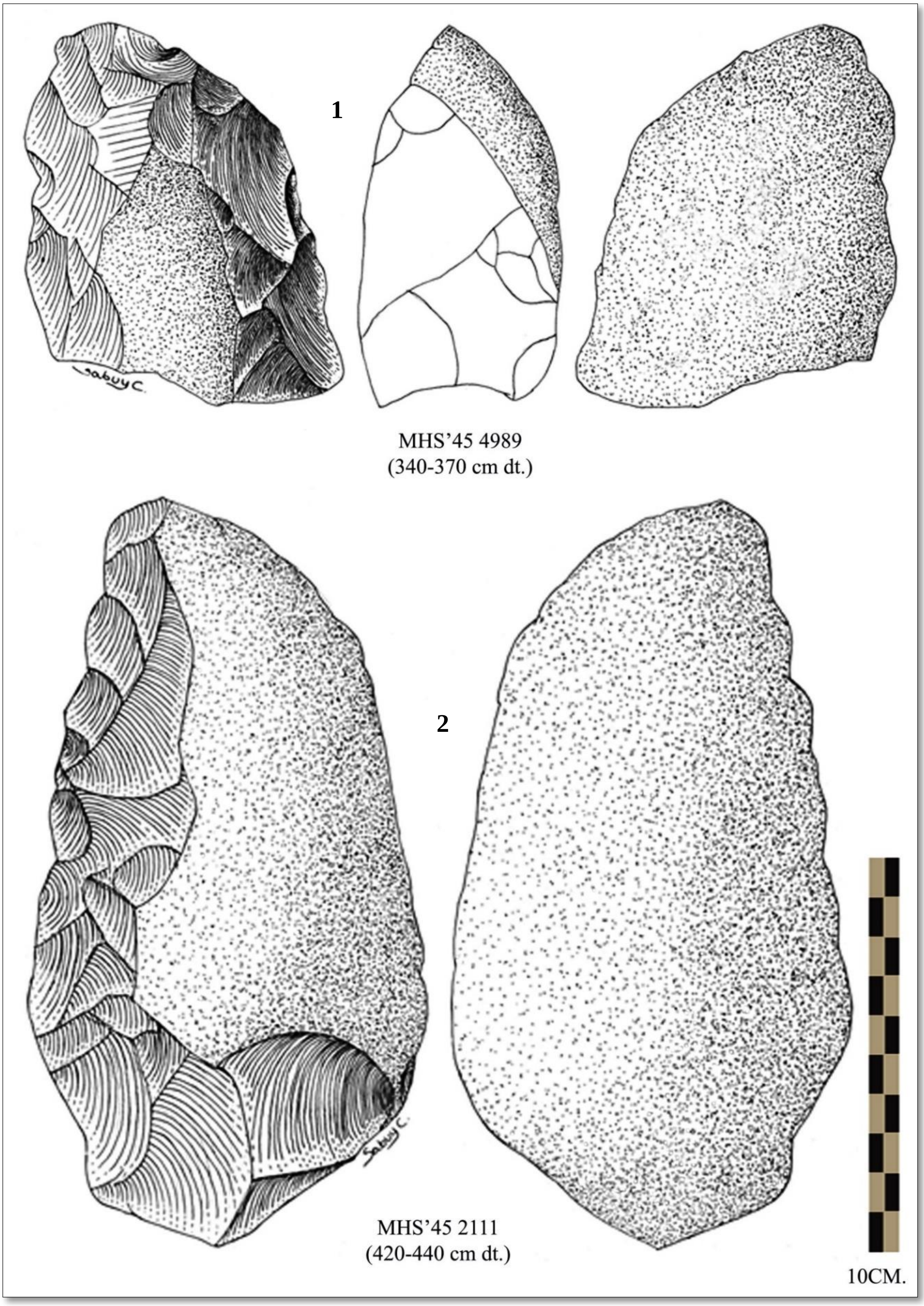


Plate 4.18 Large tools from Tham Lod Rockshelter, area 2 sector S21W10 (SEQ 3-4): layers 4 and 5 (drawings T. Chitkament). 1) ¾ sumatralith, 2) partial sumatralith

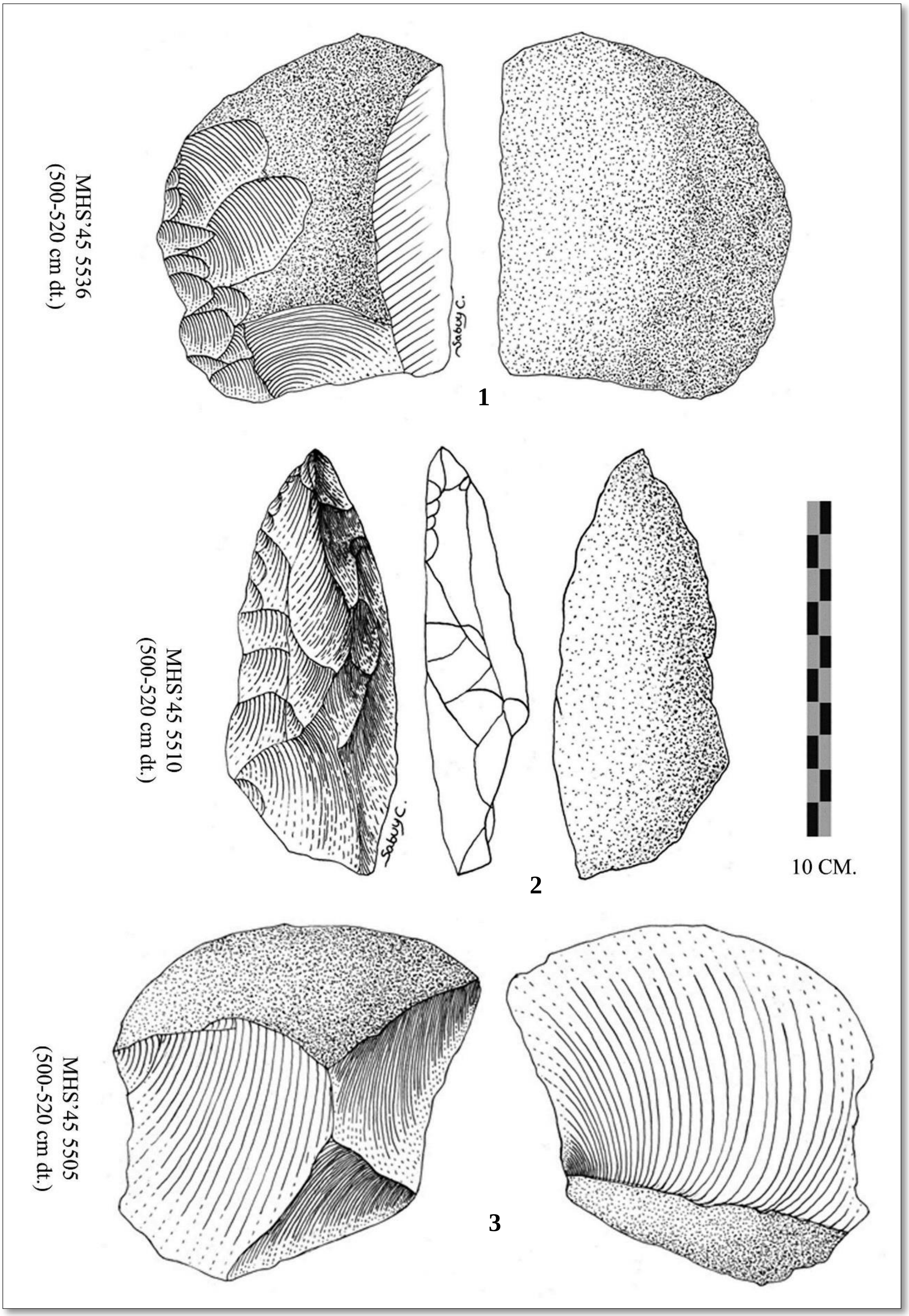


Plate 4.19 Large tools from Tham Lod Rockshelter, area 2 sector S21W10 (SEQ 3-4): layer 6 (drawings T. Chitkament). 1) partial sumatralith, 2) pointed chopper, 3) double chopper

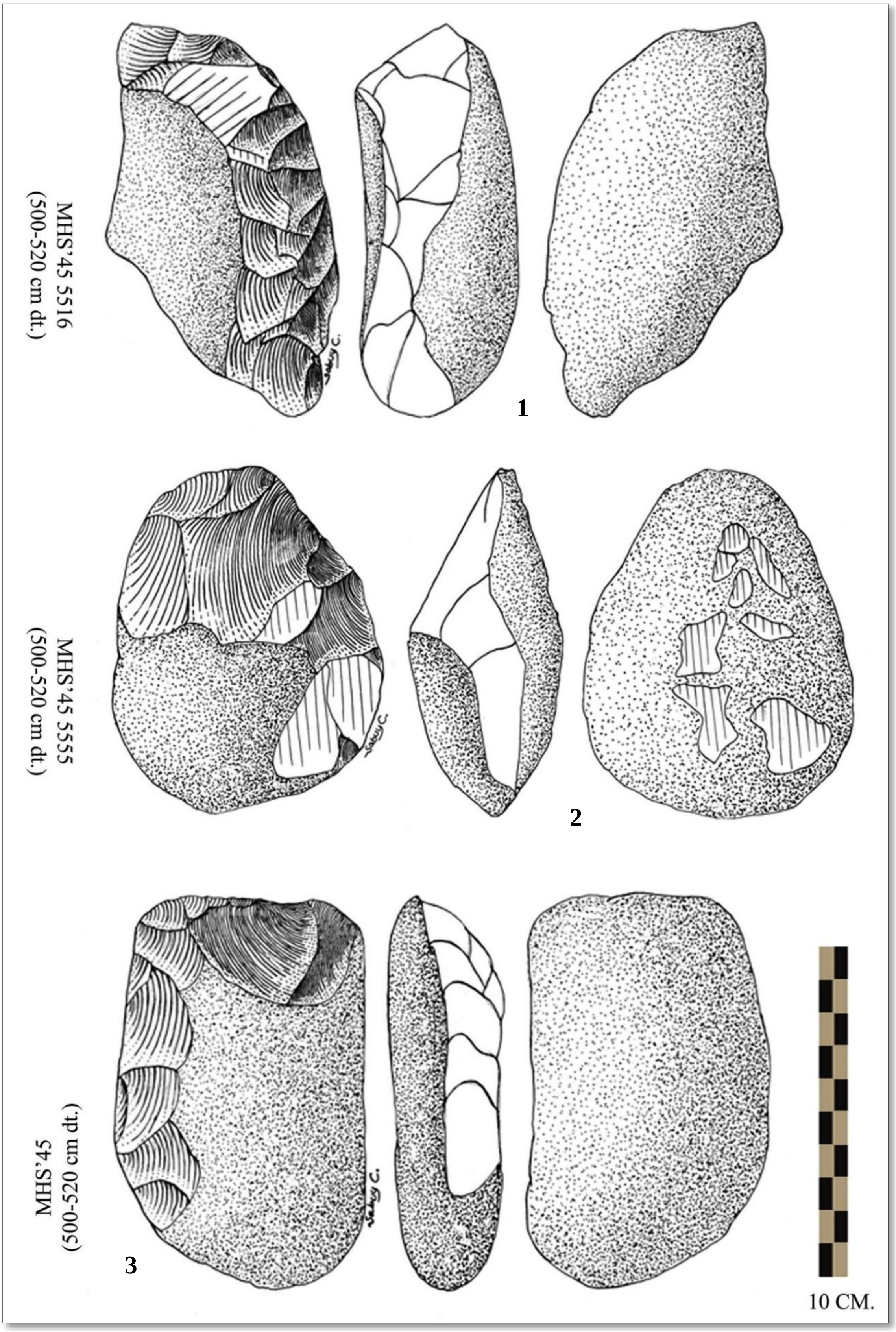


Plate 4.20 Large tools from Tham Lod Rockshelter, area 2 sector S21W10 (SEQ 3-4): layer 6 (drawings T. Chitkament). 1) ¾ sumatralith, 2) multiple chopper, 3) corner chopper (side + end chopper)

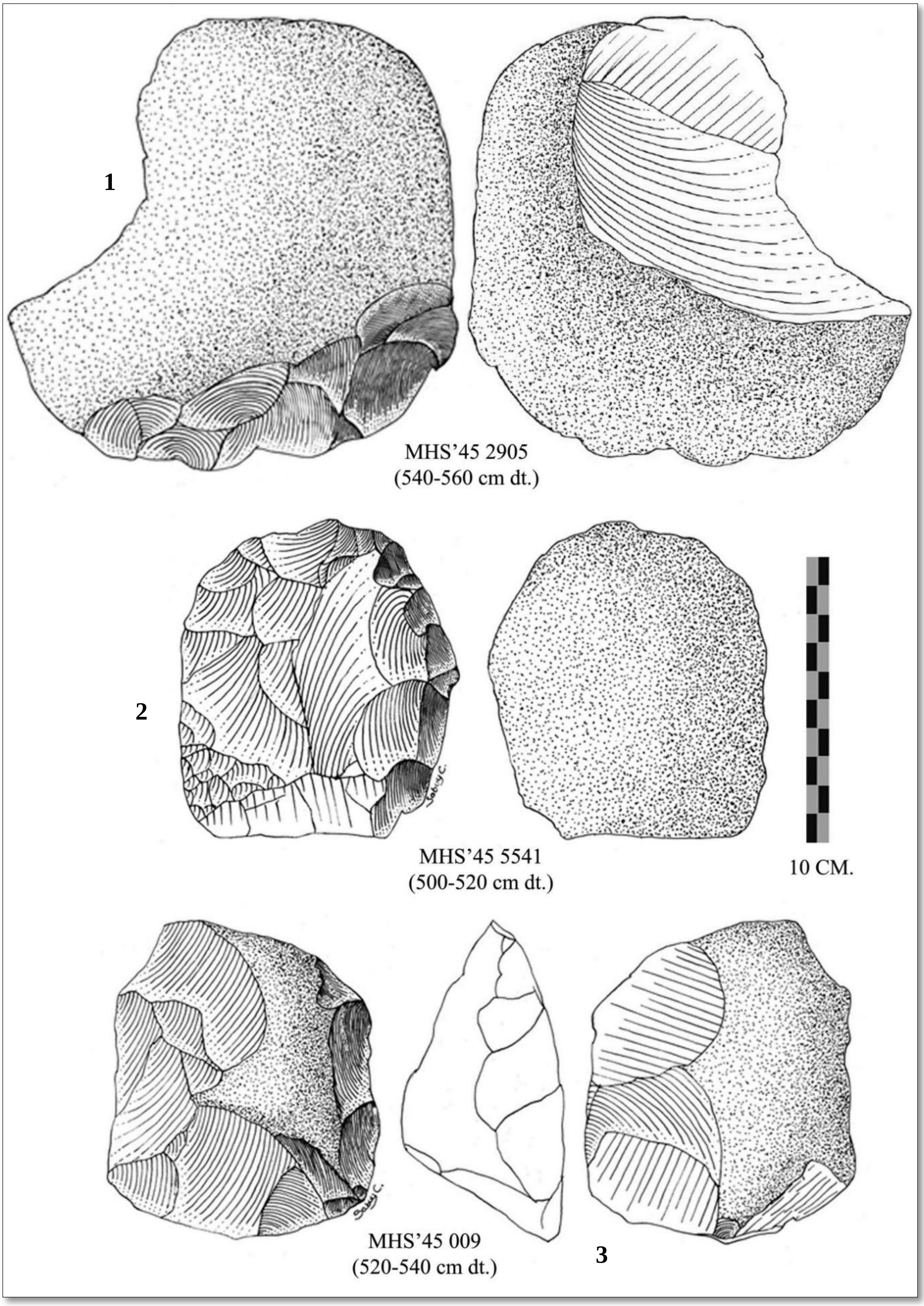


Plate 4.21 Large tools from Tham Lod Rockshelter, area 2 sector S21W10 (SEQ 3-4): layer 7 (drawings T. Chitkament). 1) end chopper, 2) unifacial discoid, 3) partly bifacial tool

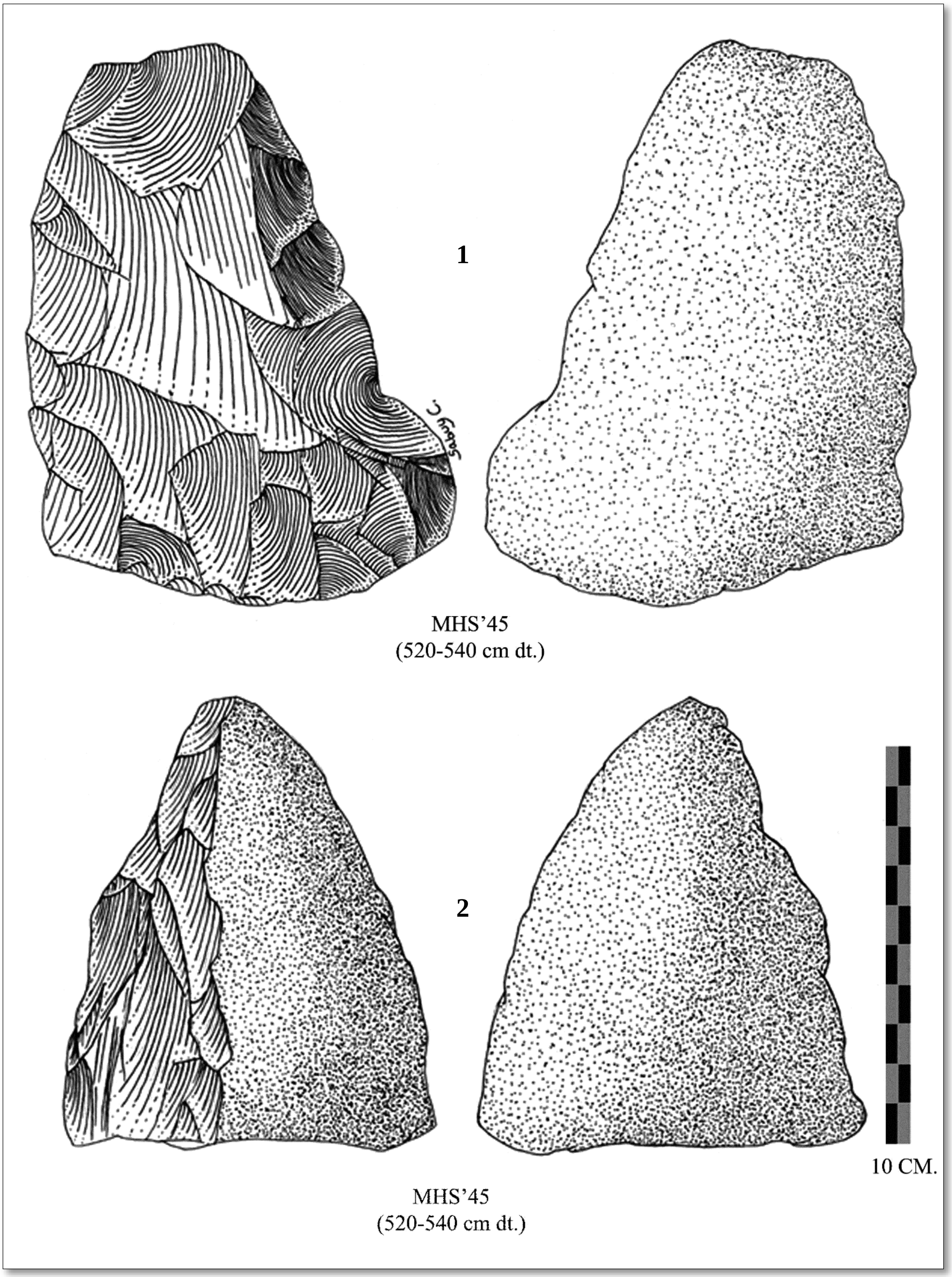


Plate 4.22 Large tools from Tham Lod Rockshelter, area 2 sector S21W10 (SEQ 3-4): layer 7 (drawings T. Chitkament). 1) typical sumatralith, 2) ¾ sumatralith

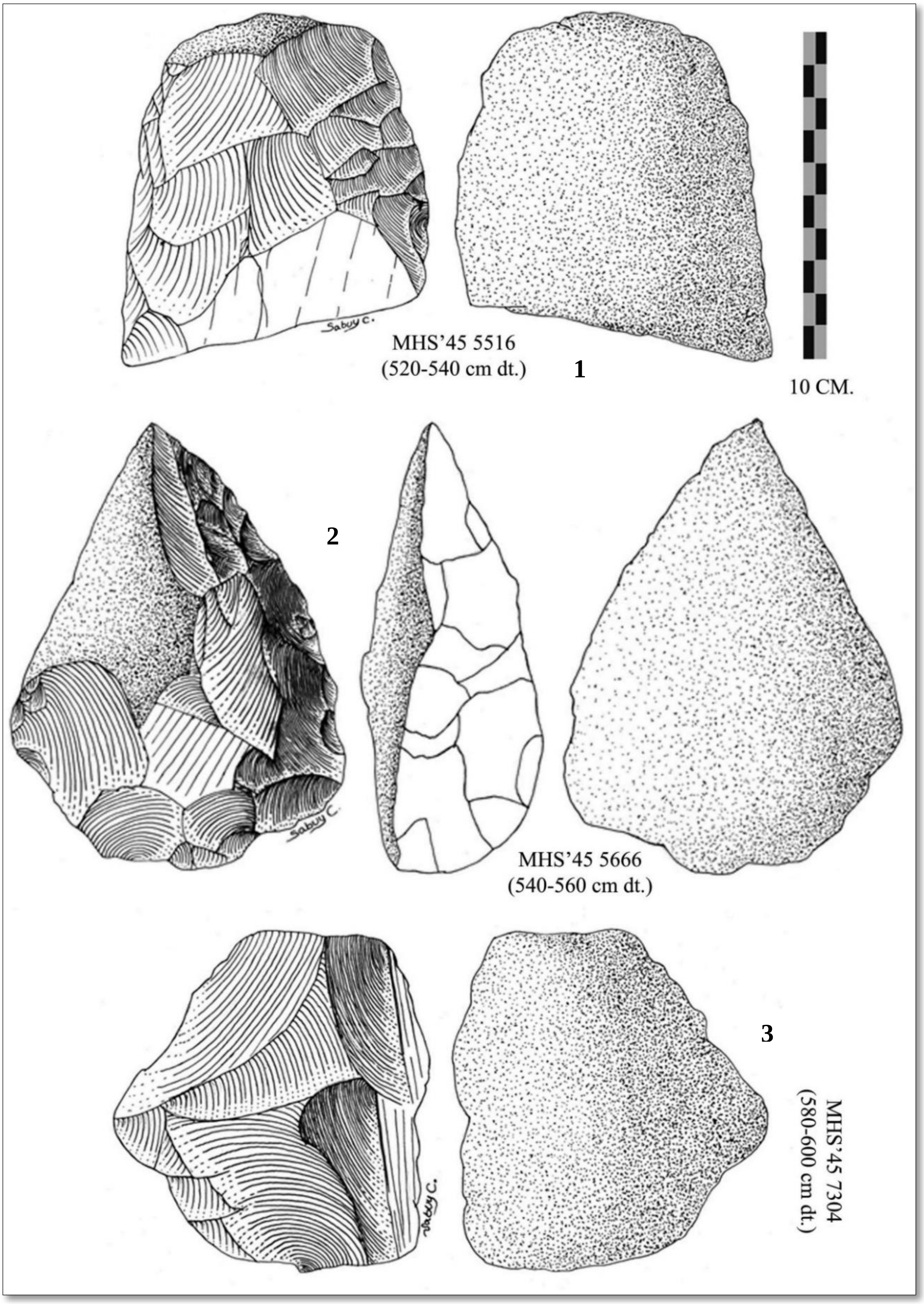


Plate 4.23 Large tools from Tham Lod Rockshelter, area 2 sector S21W10 (SEQ 3-4): layers 7 and 8 (drawings T. Chitkament). 1) ½ sumatralith, 2) multiple chopper, 3) typical sumatralith

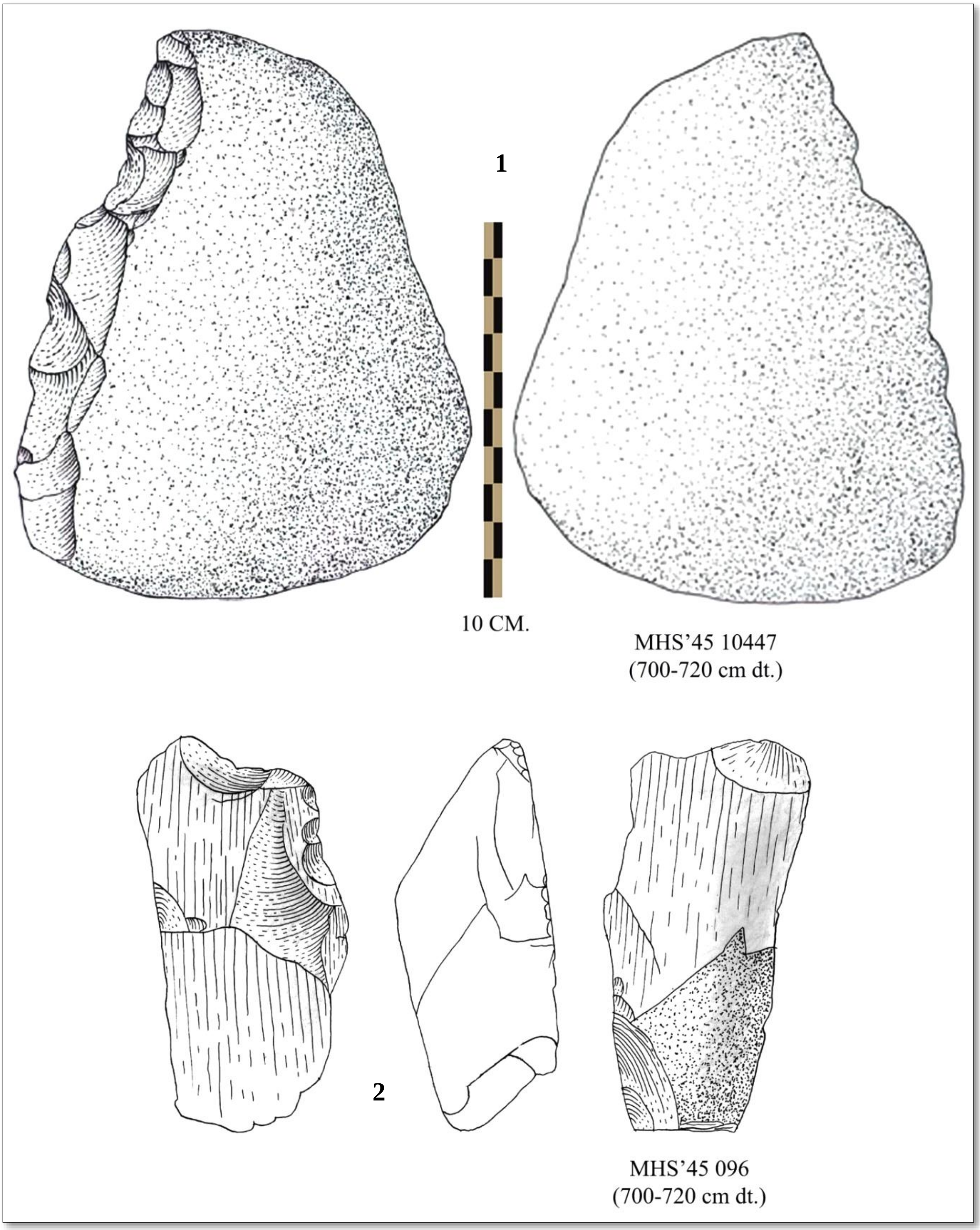


Plate 4.24 Large tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 8 (drawings T. Chitkament). 1) end chopper, 2) denticulated chopper

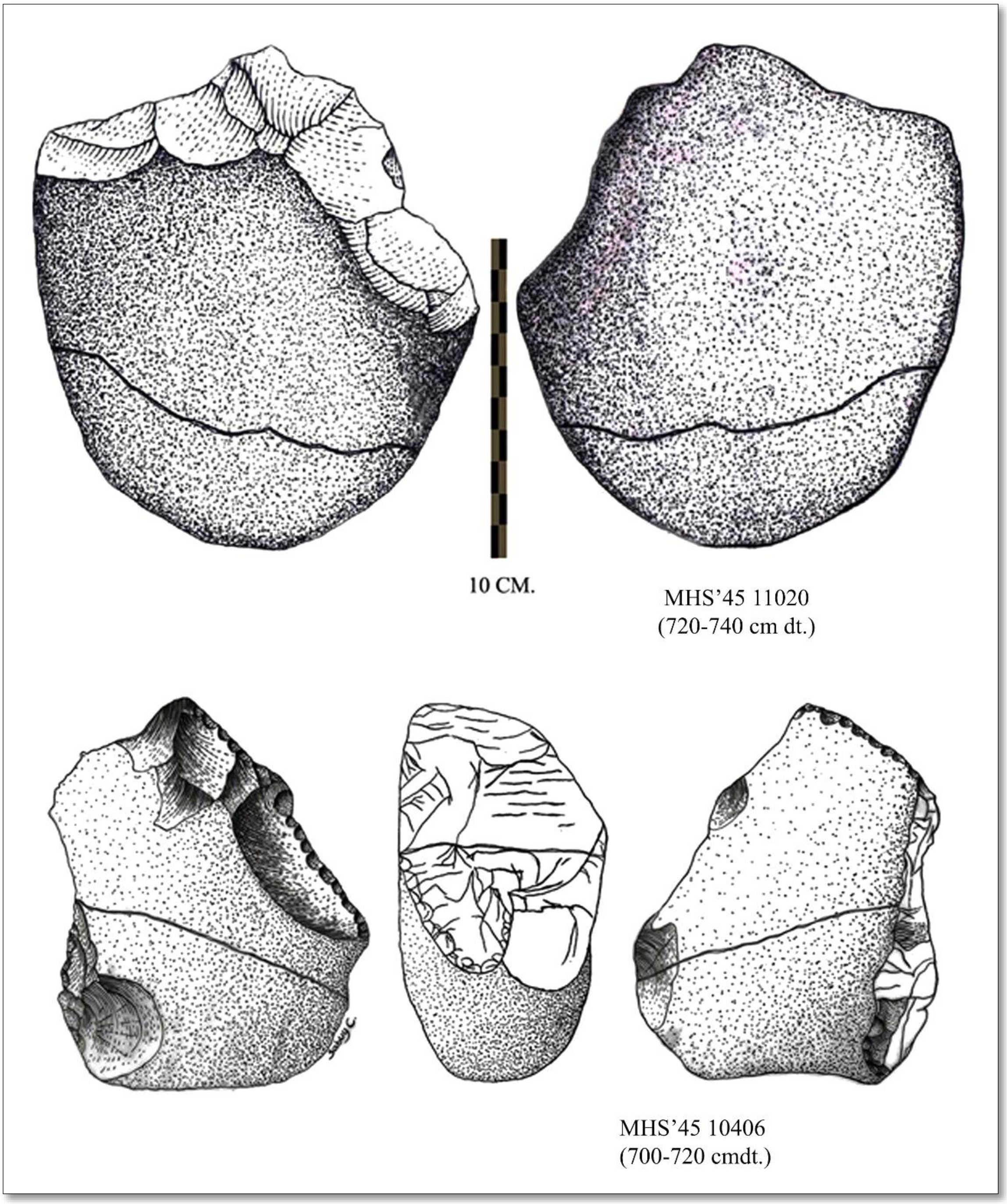


Plate 4.25 Large tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layers 8 and 9 (drawings T. Chitkament). 1) end chopper, 2) multiple chopper

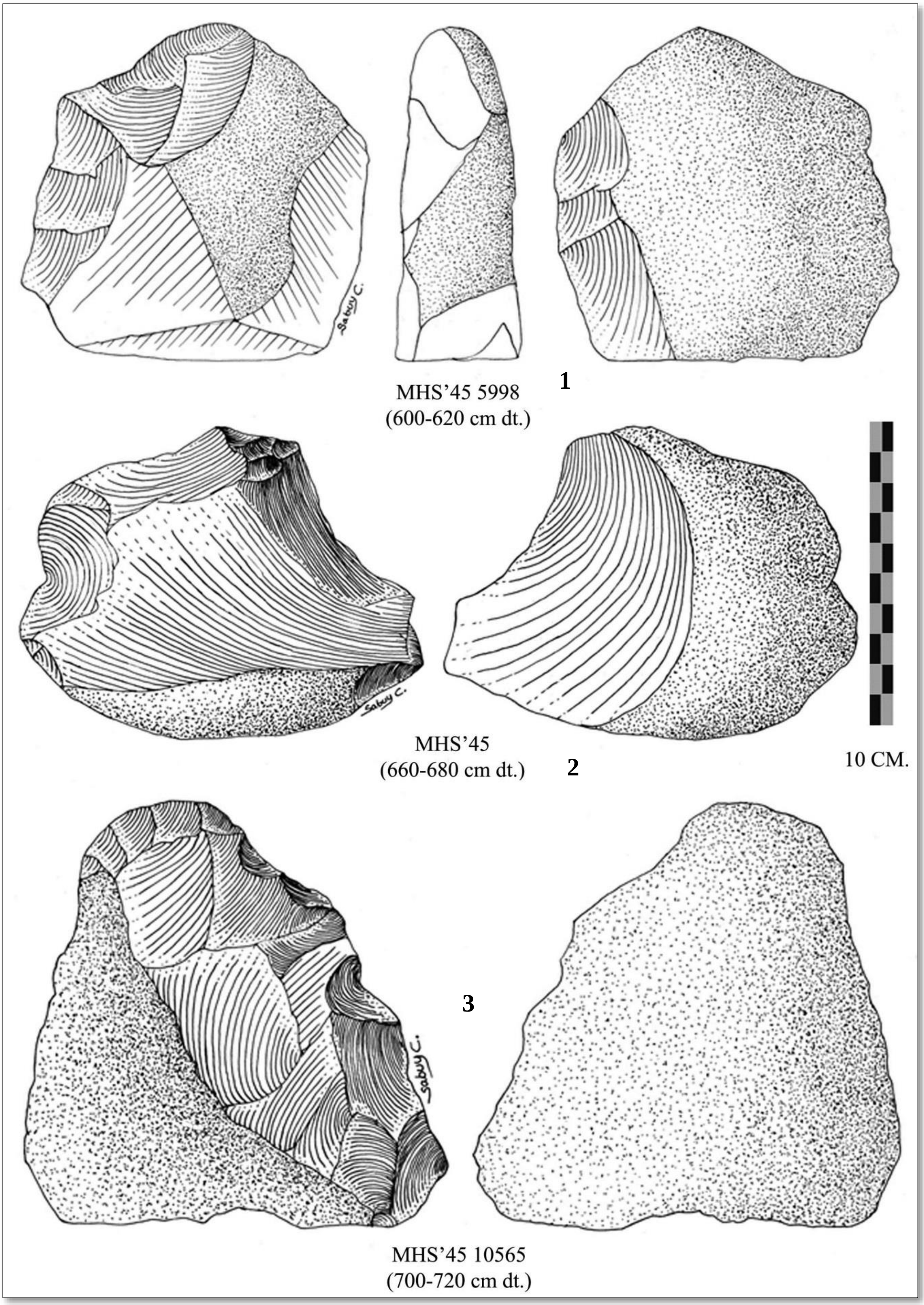


Plate 4.26 Large tools from Tham Lod Rockshelter, area 2 sector S21W10 (SEQ 3-4): layers 8, 9 and 10 (drawings T. Chitkament). 1) corner chopper, 2) multiple chopper, 3) side chopper

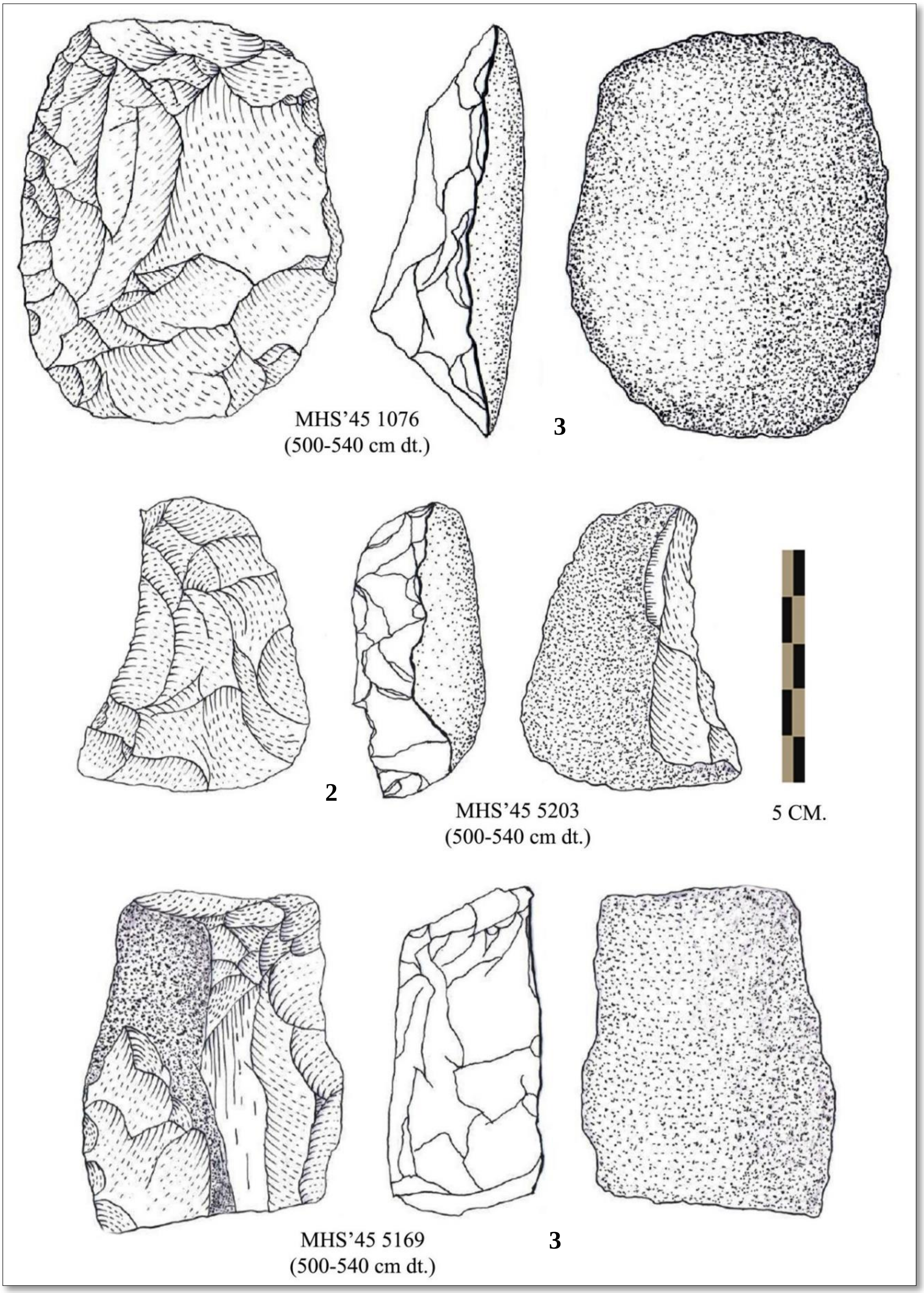


Plate 4.27 Small tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 2 (drawings T. Chitkament). 1) small typical sumatralith, 2 and 3) denticulates

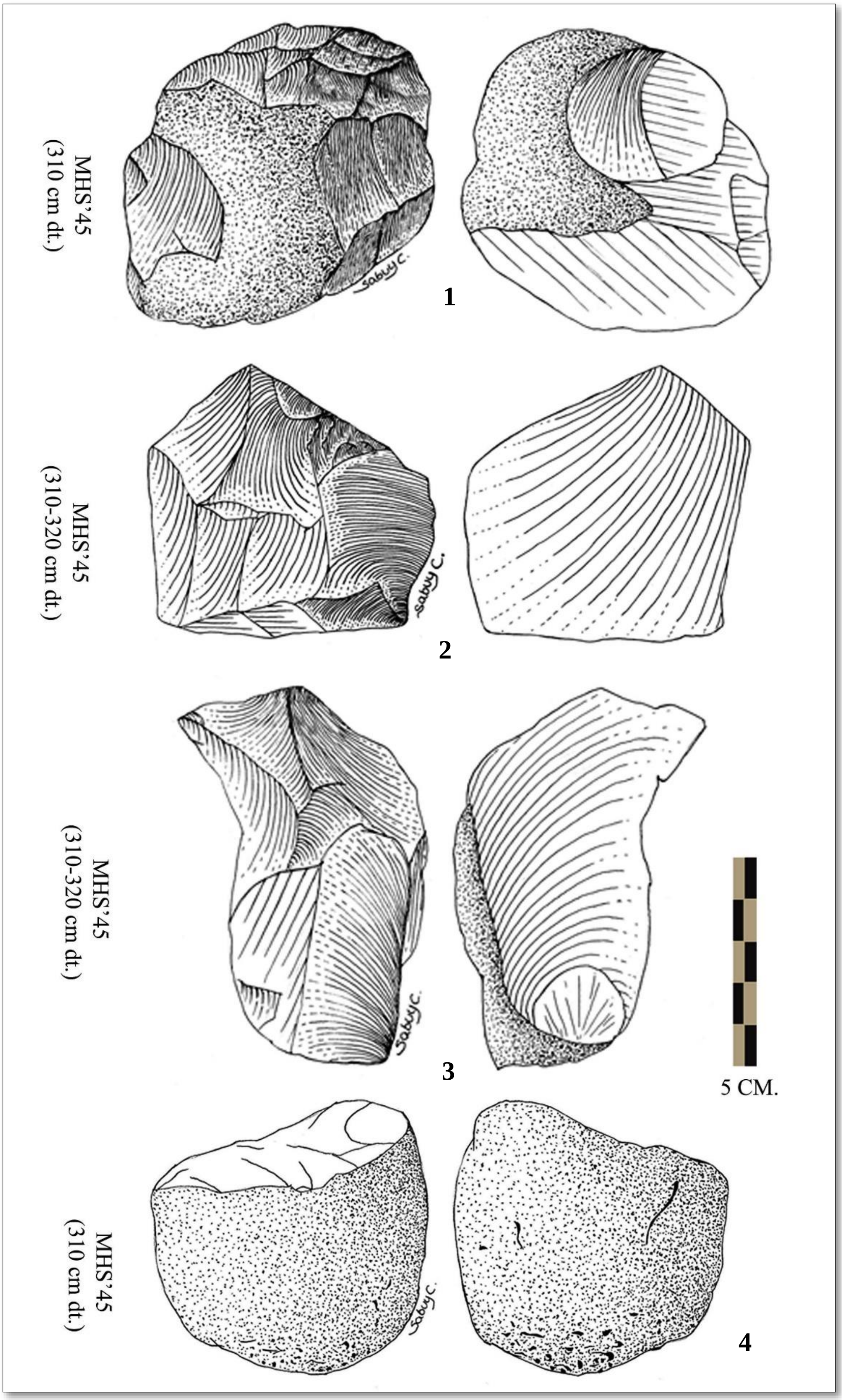


Plate 4.28 Small tools from Tham Lod Rockshelter, area 2 sector S21W10 (SEQ 3-4): layer 2 (drawings T. Chitkament). 1 and 2) multiple scrapers, 3) beak scraper, 4) atypical small tool

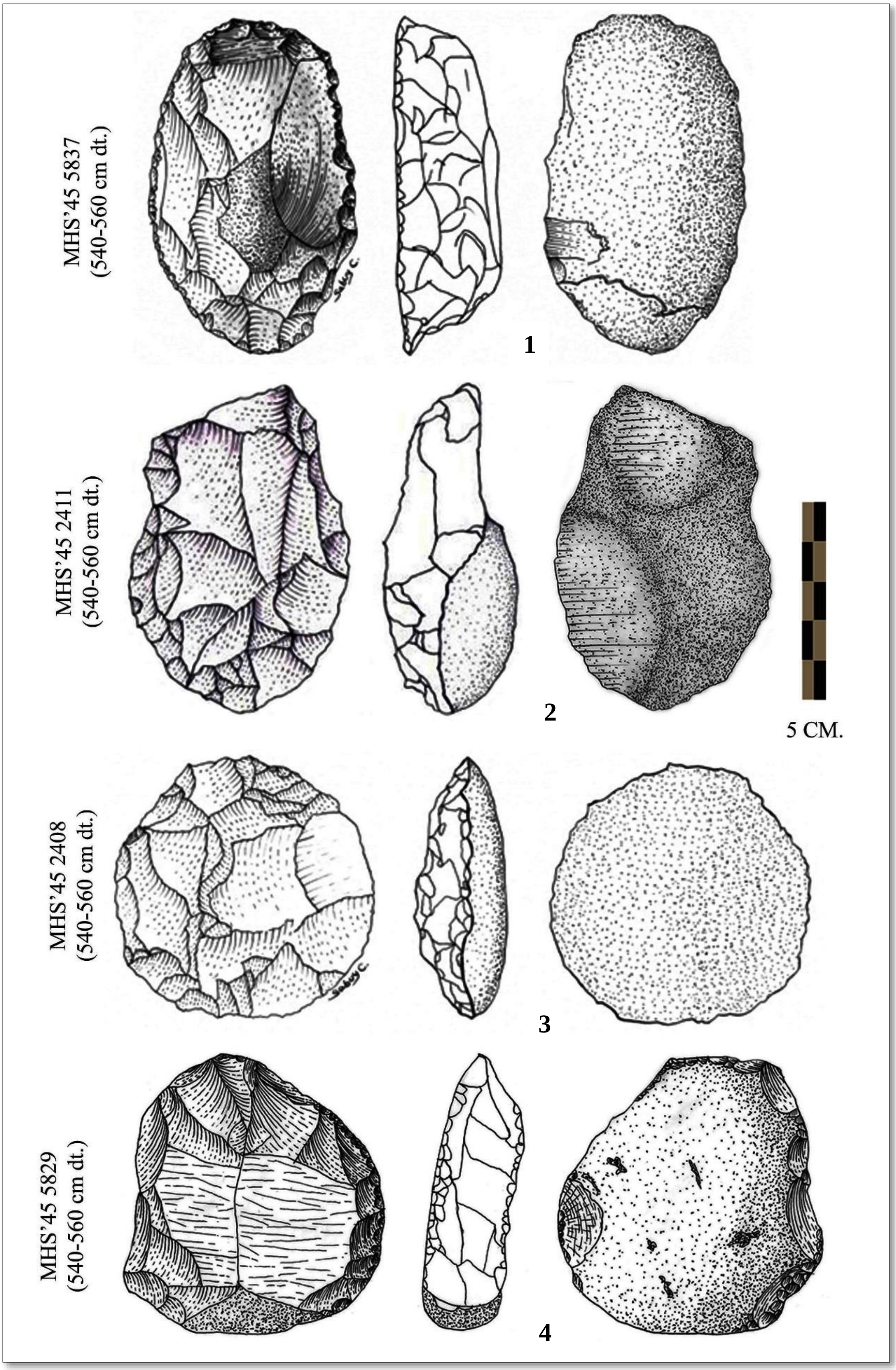


Plate 4.29 Small tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 3 (drawings T. Chitkament). 1 and 2) small typical sumatraliths, 3) unifacial discoid, 4) multiple scraper

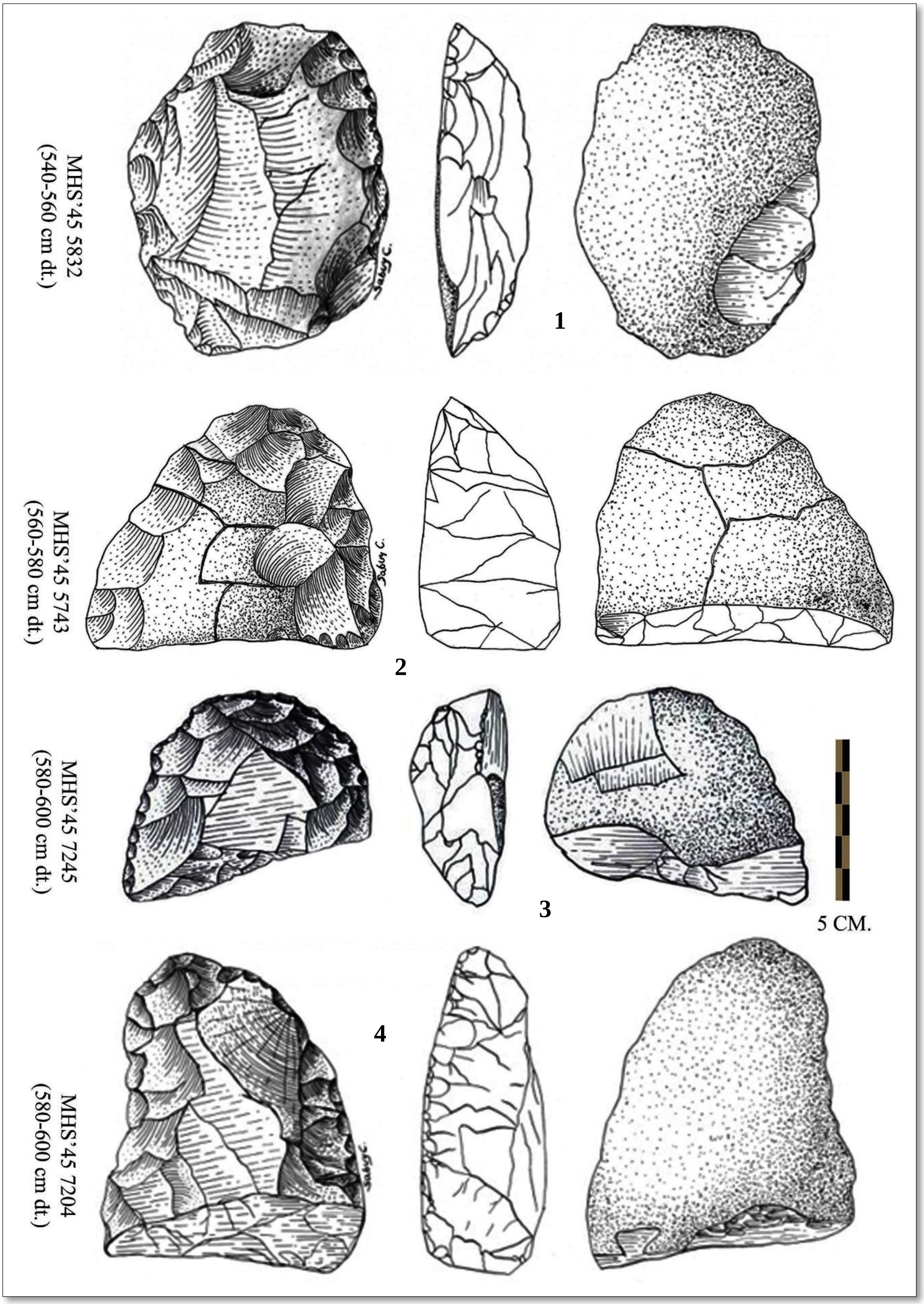


Plate 4.30 Small tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 3 (drawings T. Chitkament). 1) small typical sumatralith, 2 and 3) ½ sumatraliths, ¾ sumatralith

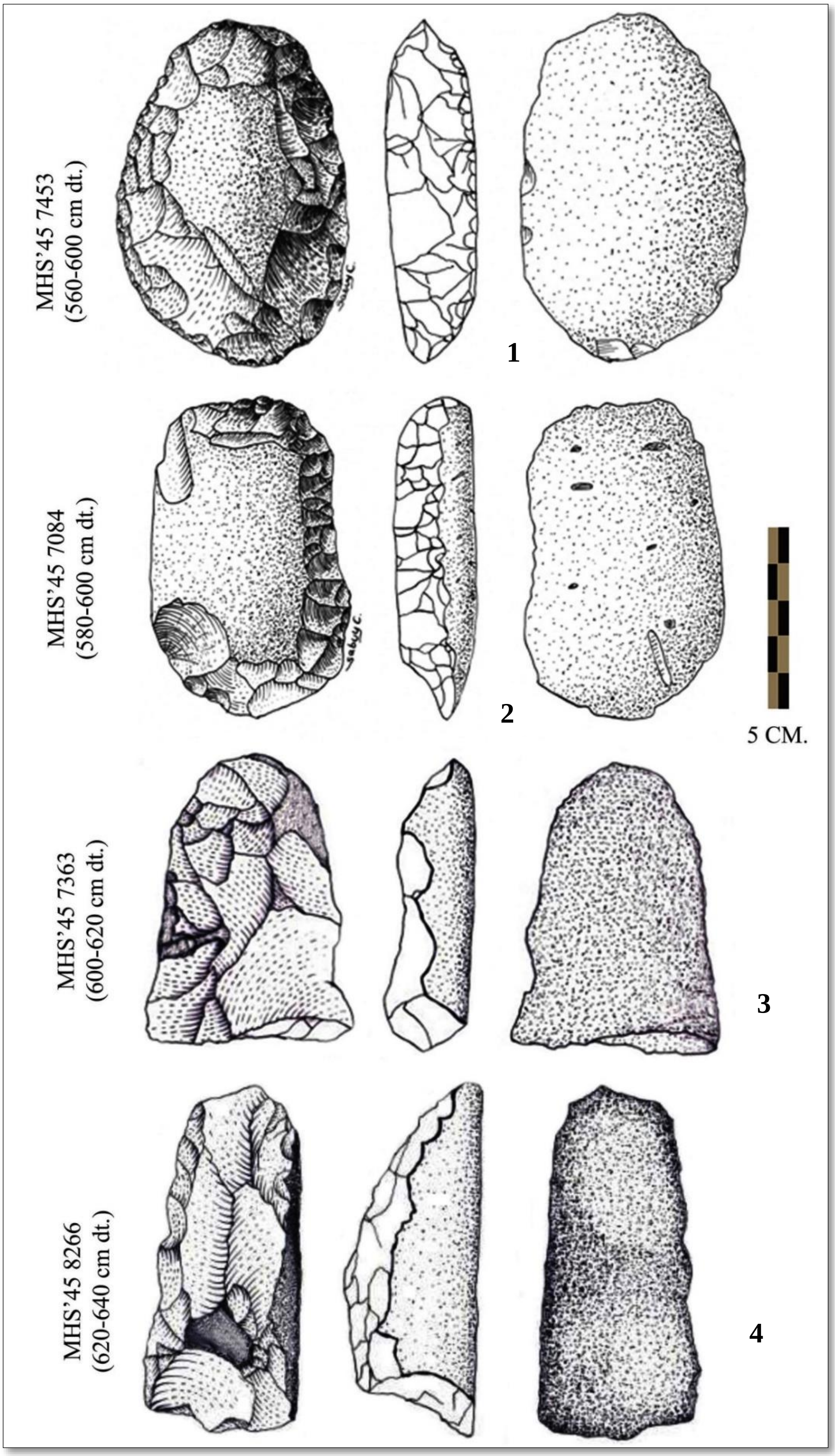


Plate 4.31 Small tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 3 (drawings T. Chitkament). 1) small typical sumatralith, 2) small partial sumatralith, 3 and 4) ¾ sumatraliths

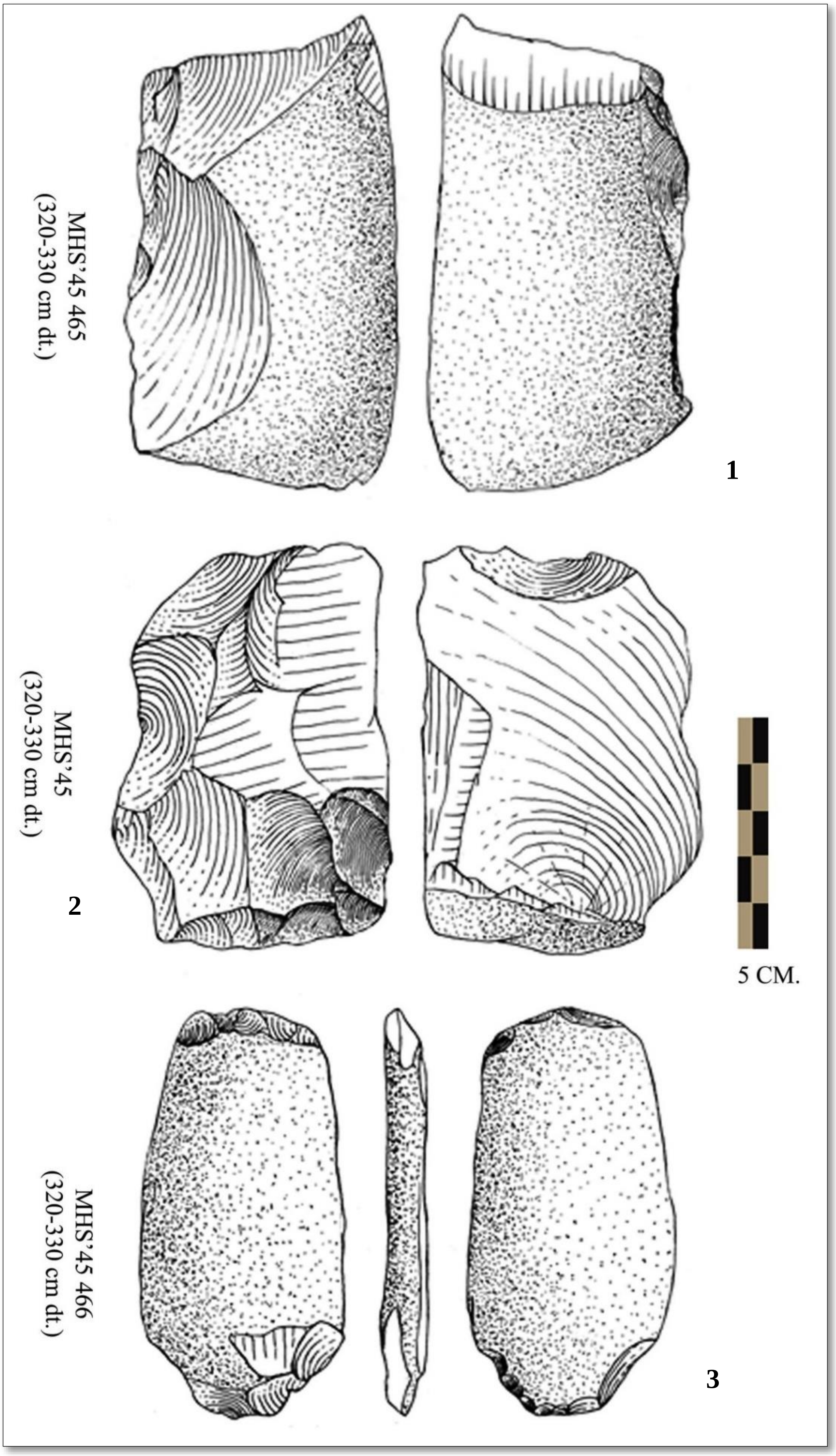


Plate 4.32 Small tools from Tham Lod Rockshelter, area 2 sector S21W10 (SEQ 3-4): layer 3 (drawings T. Chitkament). 1) denticulate, 2) multiple scraper, 3) double scraper

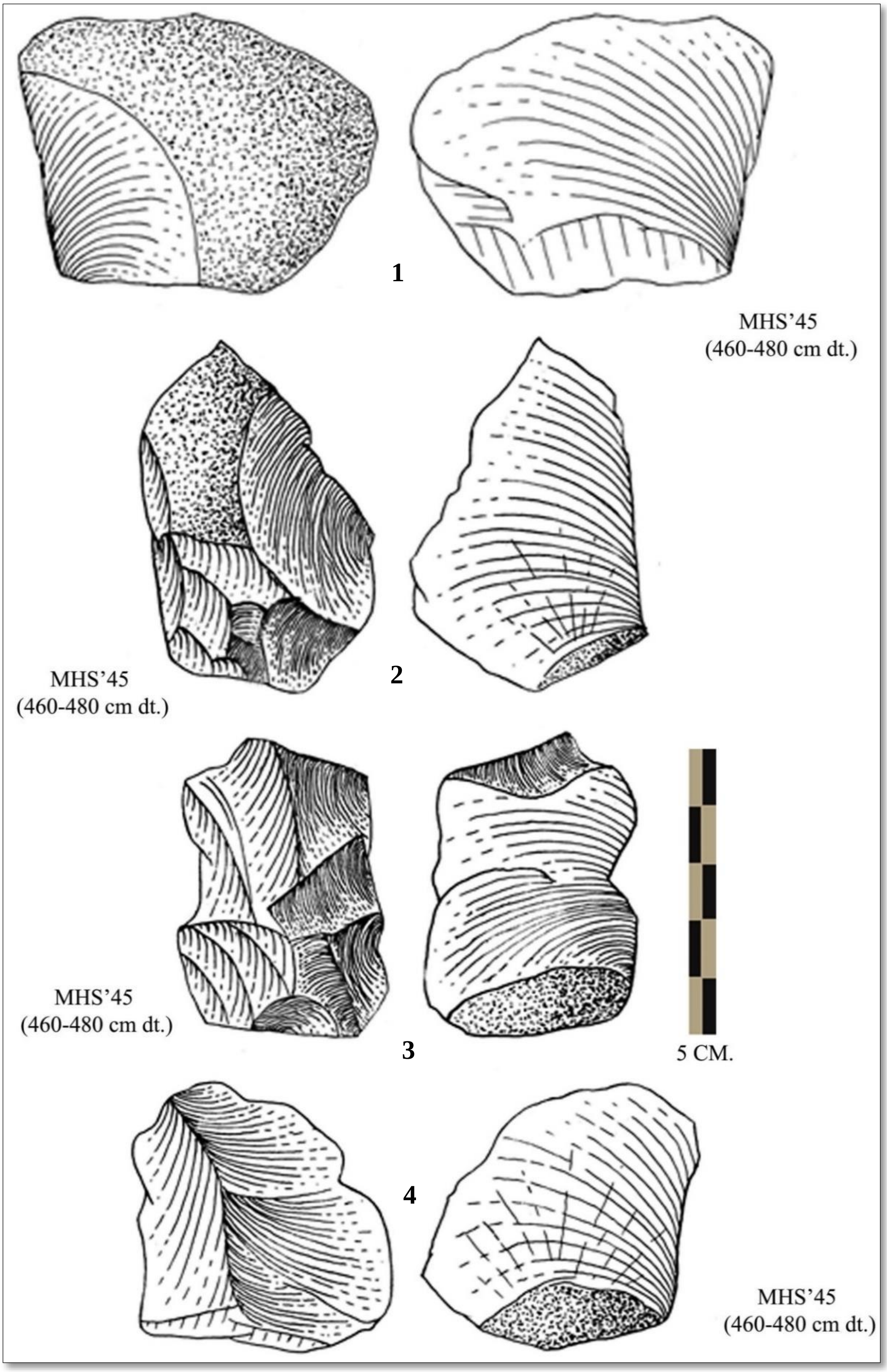


Plate 4.33 Small tools from Tham Lod Rockshelter, area 2 sector S21W10 (SEQ 3-4): layer 5 (drawings T. Chitkament). 1, 2, 3 and 4) atypical small tools

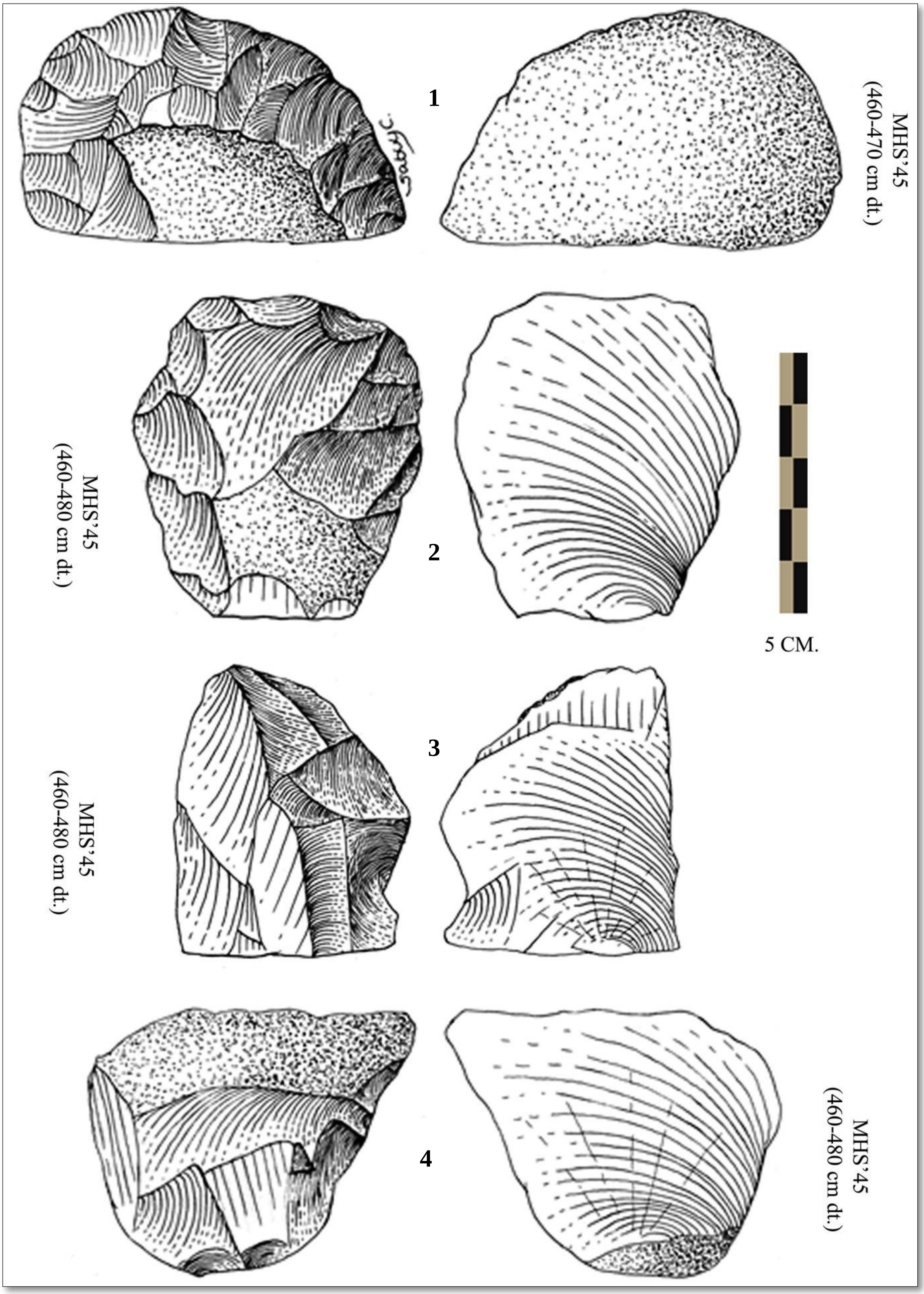


Plate 4.34 Small tools from Tham Lod Rockshelter, area 2 sector S21W10 (SEQ 3-4): layer 5 (drawings T. Chitkament). 1) ½ small sumatralith, 2) multiple scraper, 3 and 4) denticulates

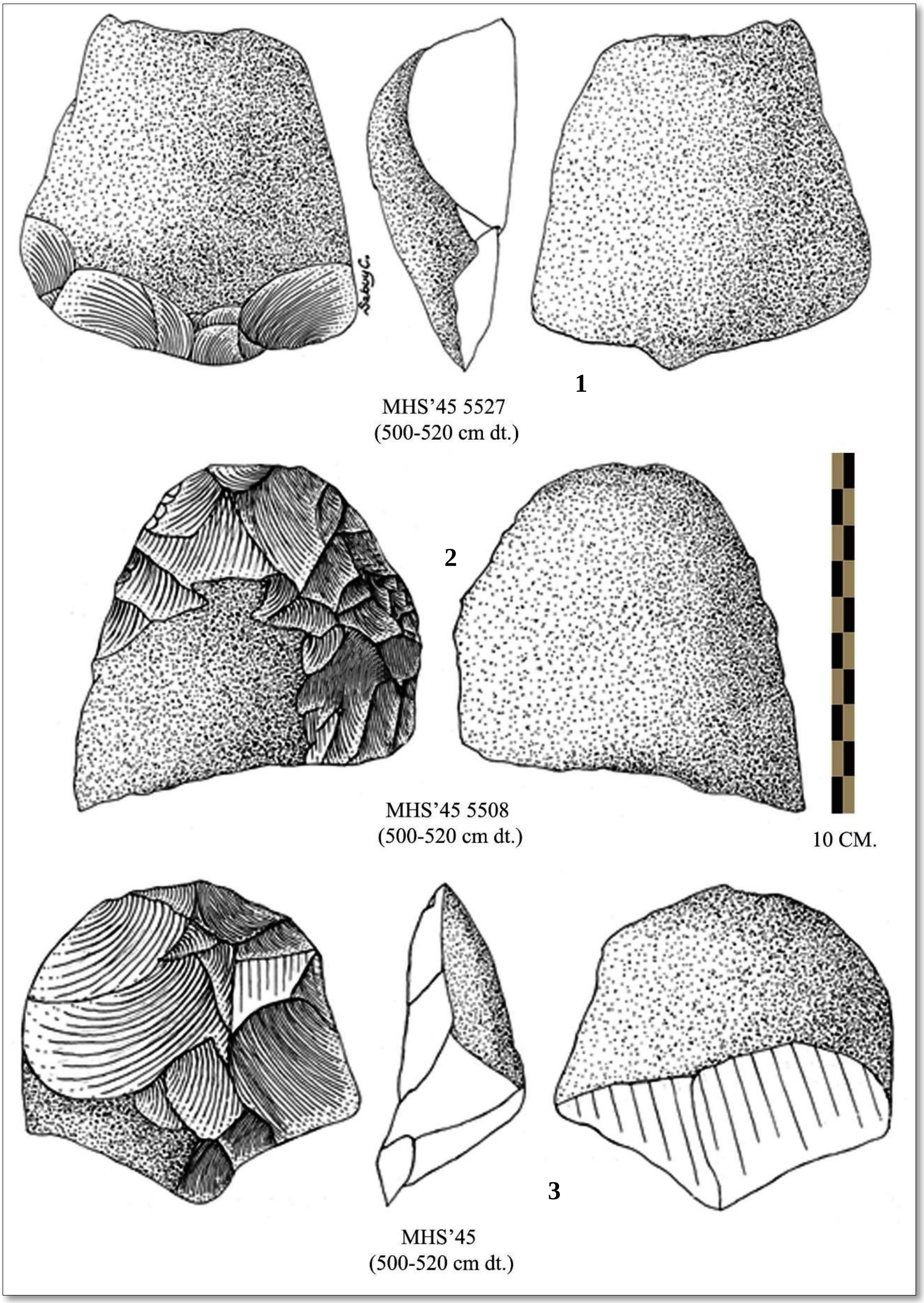


Plate 4.35 Small tools from Tham Lod Rockshelter, area 2 sector S21W10 (SEQ 3-4): layer 6 (drawings T. Chitkament). 1) end scraper, 2 and 3) ½ small sumatraliths

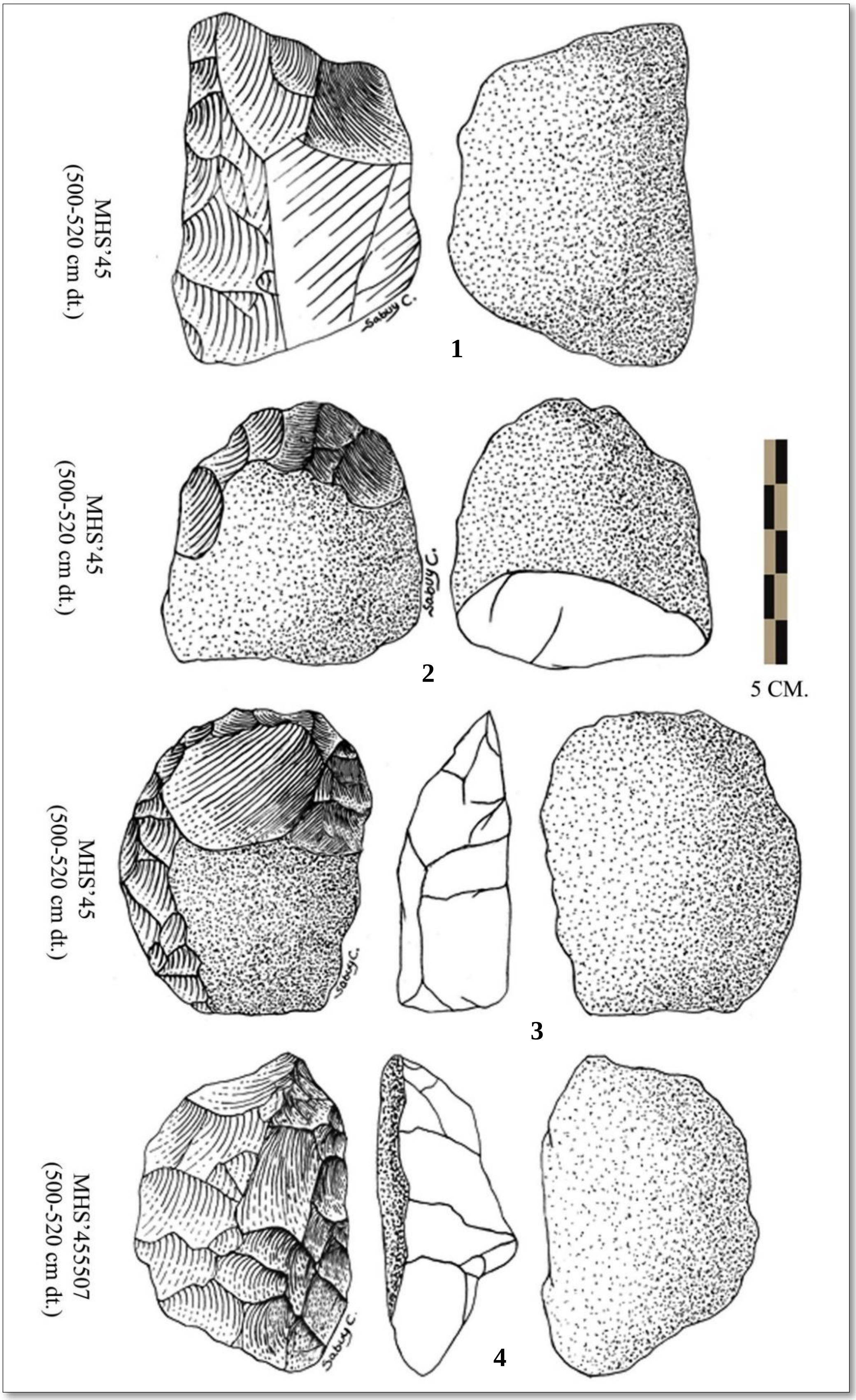


Plate 4.36 Small tools from Tham Lod Rockshelter, area 2 sector S21W10 (SEQ 3-4): layer 6 (drawings T. Chitkament). 1 and 4) small typical sumatraliths, 2) ½ small partial sumatralith, 3) small partial sumatralith

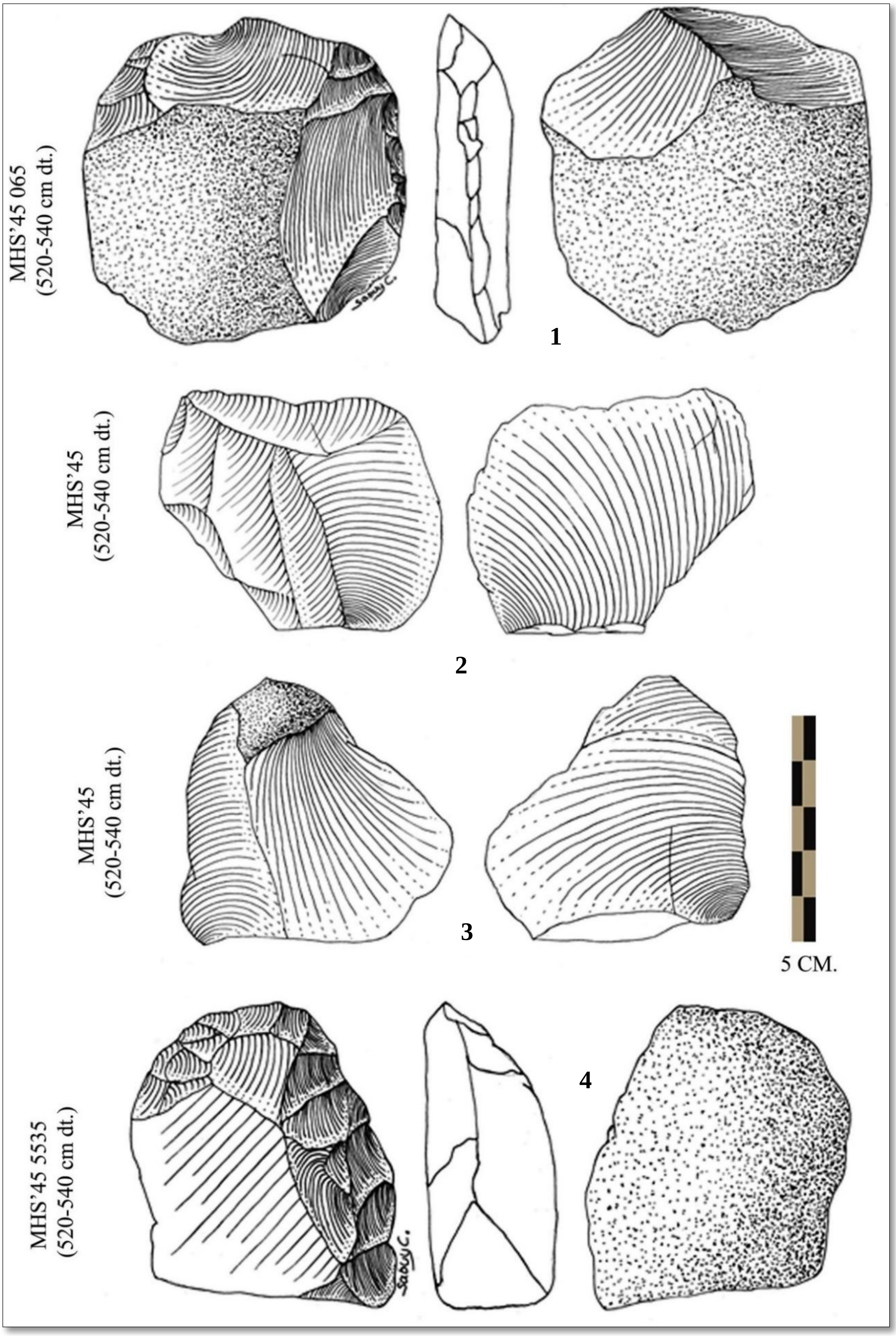


Plate 4.37 Small tools from Tham Lod Rocksheler, area 2 sector S21W10 (SEQ 3-4): layer 7 (drawings T. Chitkament). 1) small partial sumatralith, 2 and 3) atypical small tools, 4) ¾ small typical sumatralith

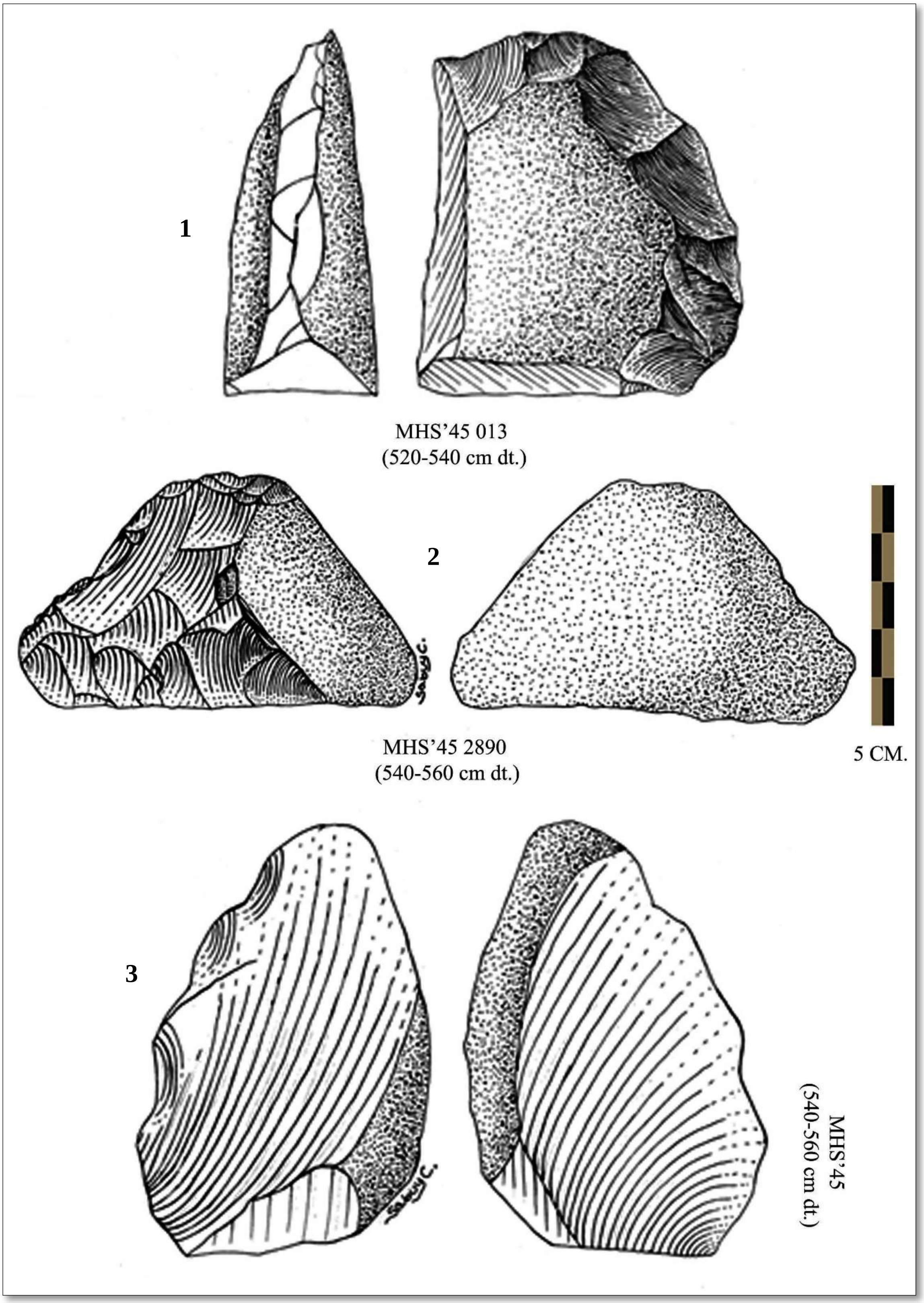


Plate 4.38 Small tools from Tham Lod Rocksheler, area 2 sector S21W10 (SEQ 3-4): layer 7 (drawings T. Chitkament). 1 and 2) ½ small sumatraliths, 3) denticulate

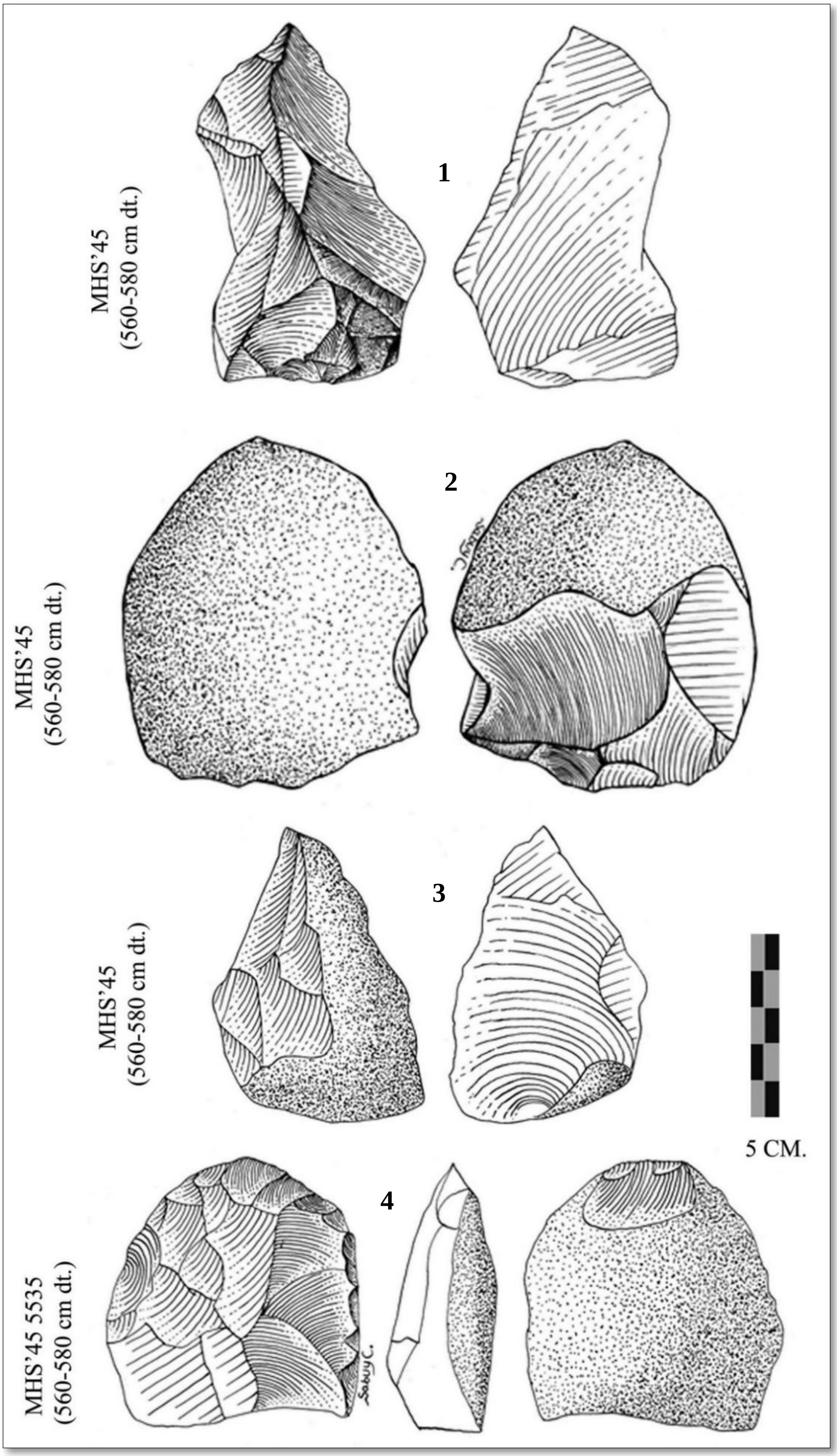


Plate 4.39 Small tools from Tham Lod Rockshelter, area 2 sector S21W10 (SEQ 3-4): layer 7 (drawings T. Chitkament). 1) beak scrapers, 2) end scraper, 3) pointed tool, 4) ¾ small sumatralith

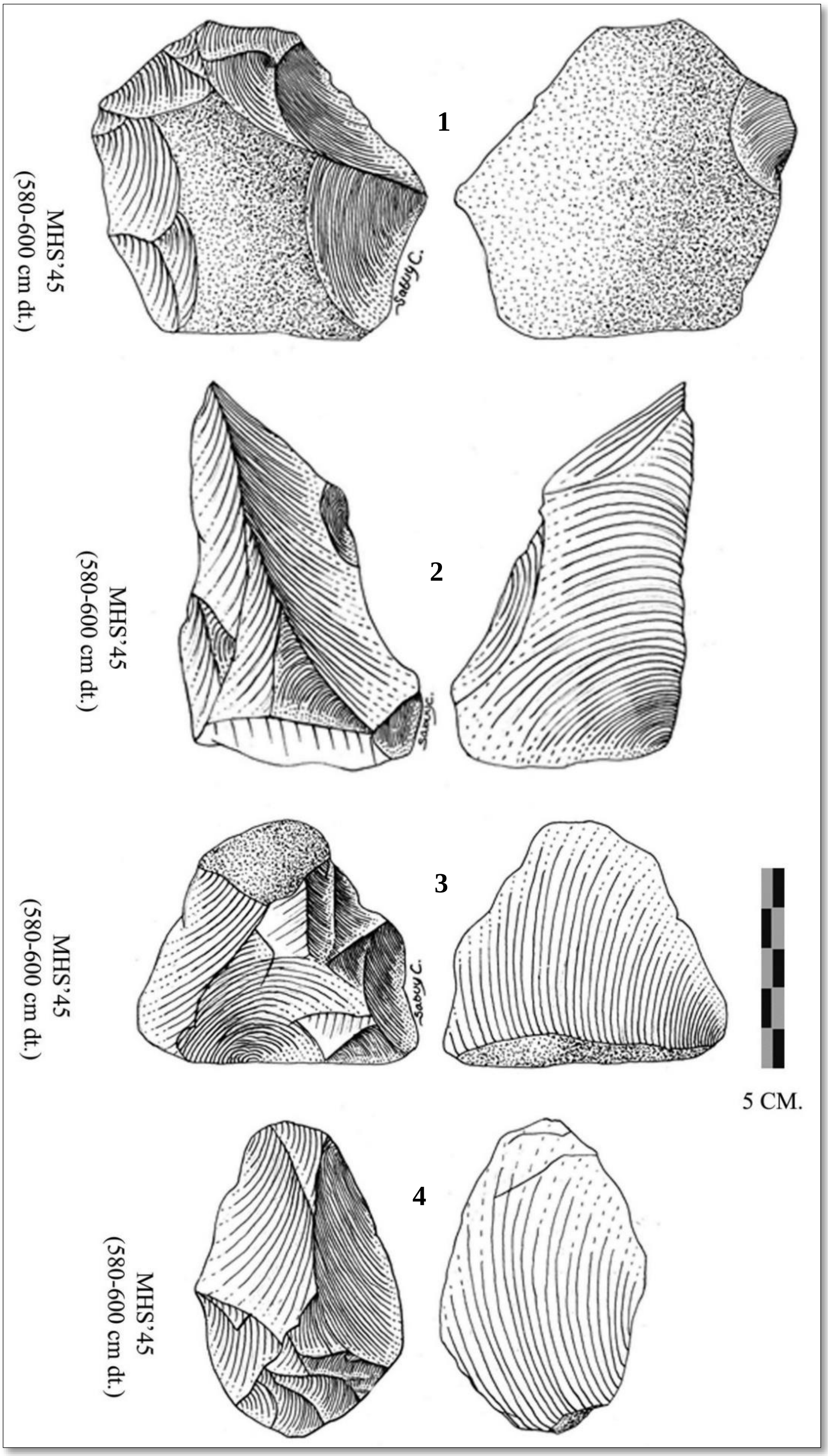


Plate 4.40 Small tools from Tham Lod Rockshelter, area 2 sector S21W10 (SEQ 3-4): layer 8 (drawings T. Chitkament). 1) multiple scrapers, 2) pointed tool, 3) denticulate, 4) atypical small tool

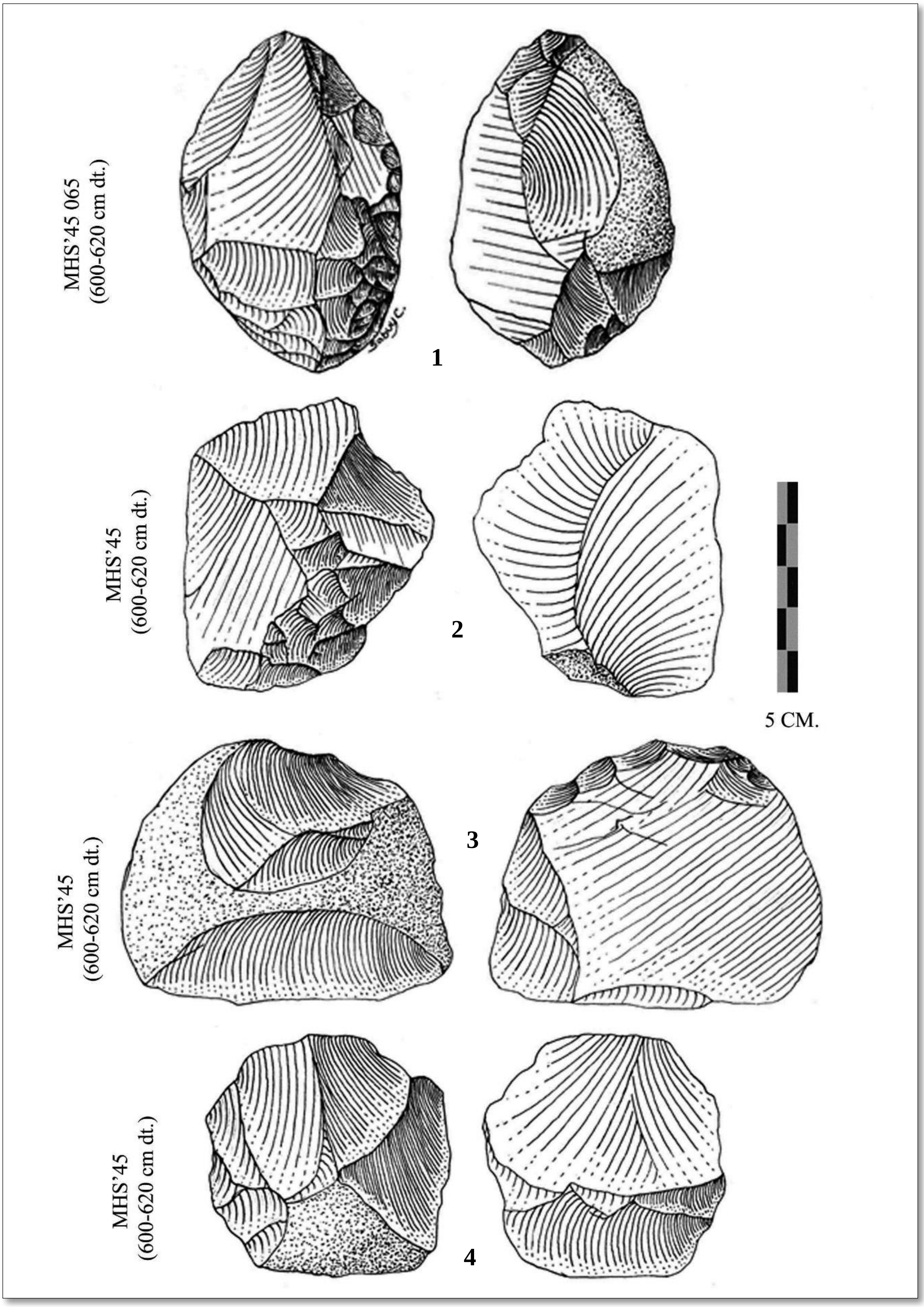


Plate 4.41 Small tools from Tham Lod Rockshelter, area 2 sector S21W10 (SEQ 3-4): layer 8 (drawings T. Chitkament). 1) small sumatralith, 2) side scraper, 3) denticulate, 4) multiple scraper

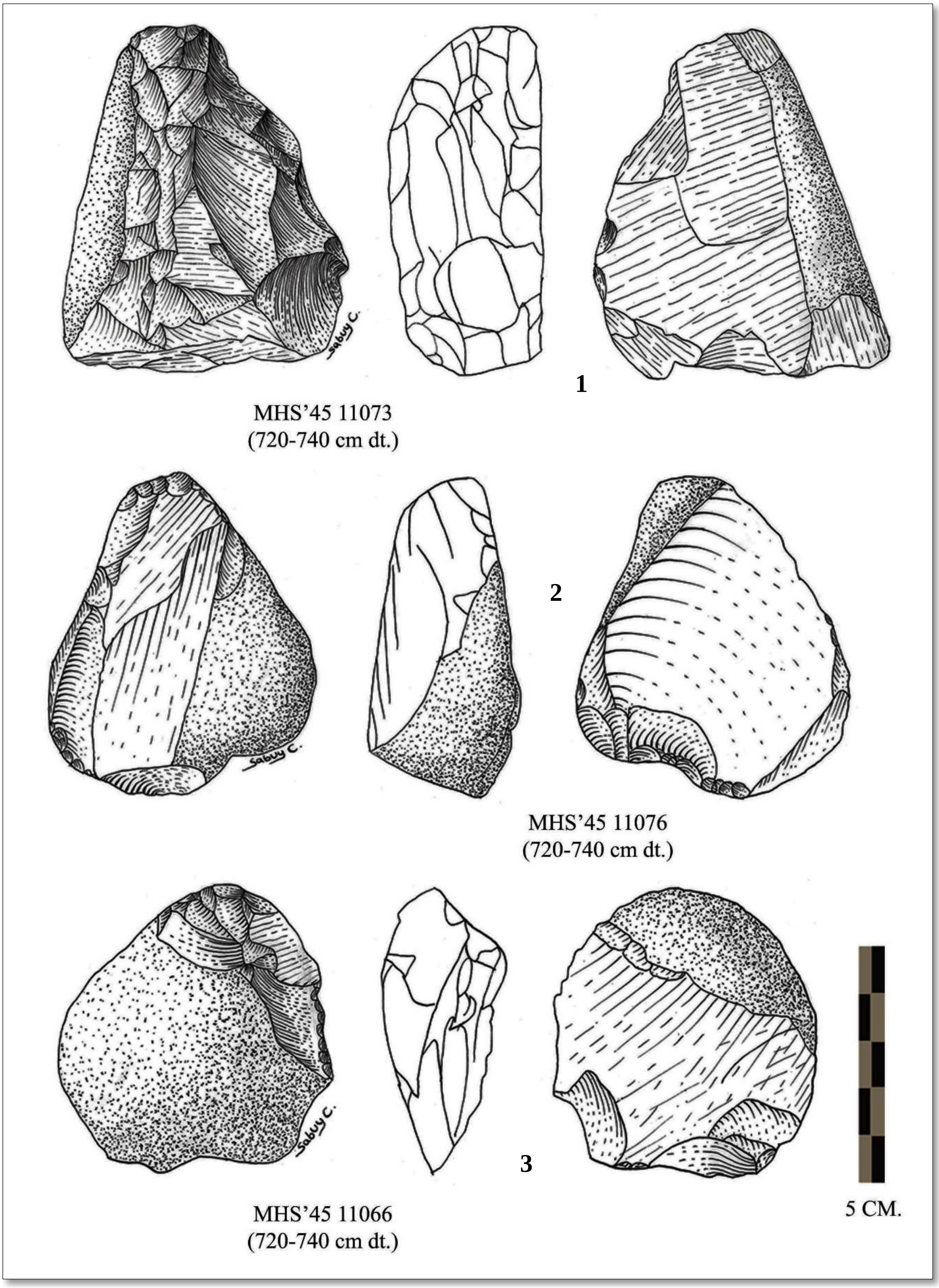


Plate 4.42 Small tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 9 (drawings T. Chitkament). 1) nose scraper, 2 and 3) multiple scrapers

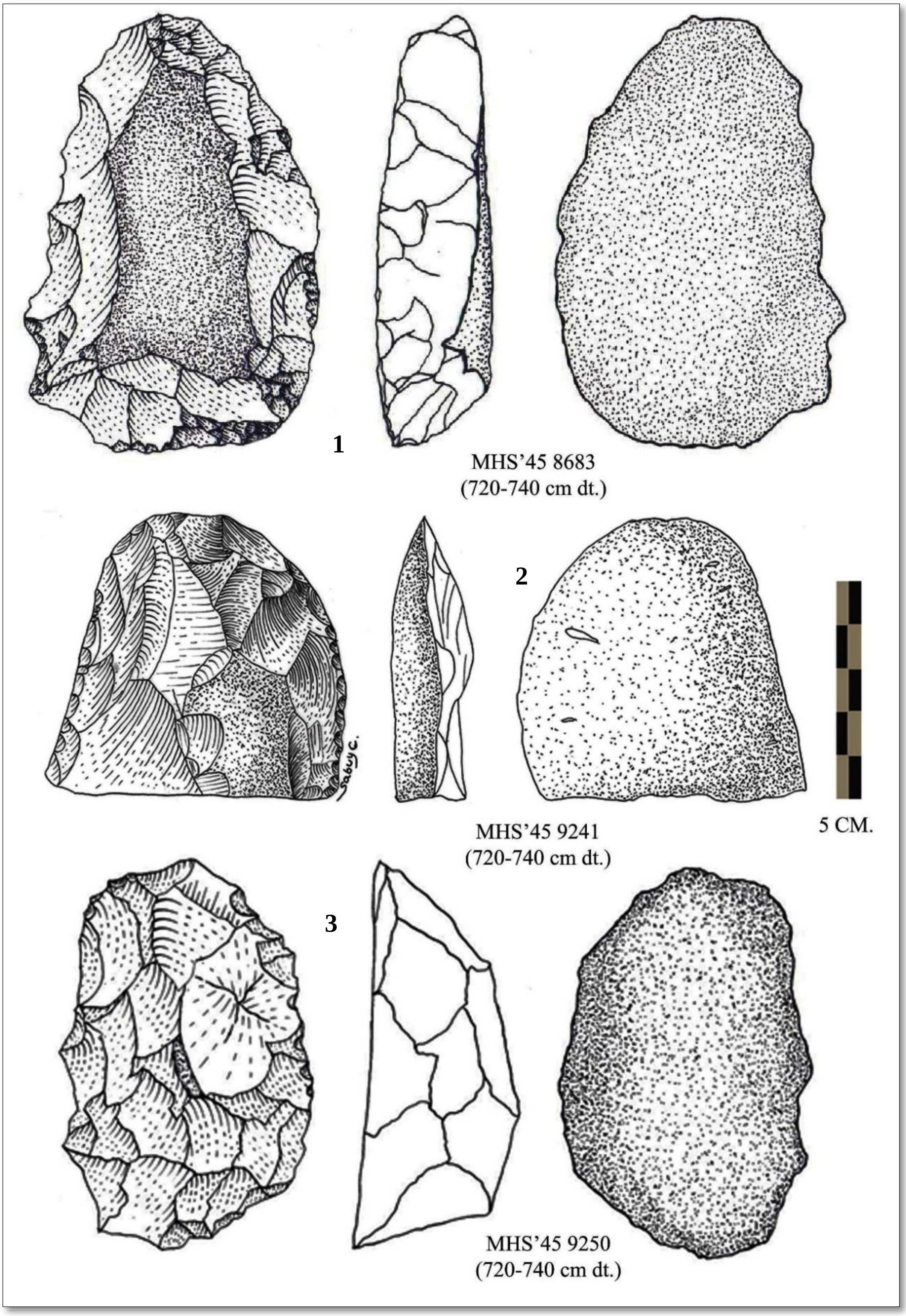


Plate 4.43 Small tools from Tham Lod Rockshelter, area 2 sector S20W10 (SEQ 3-4): layer 9 (drawings T. Chitkament). 1 and 3) small typical sumatraliths, 2) ½ small sumatralith

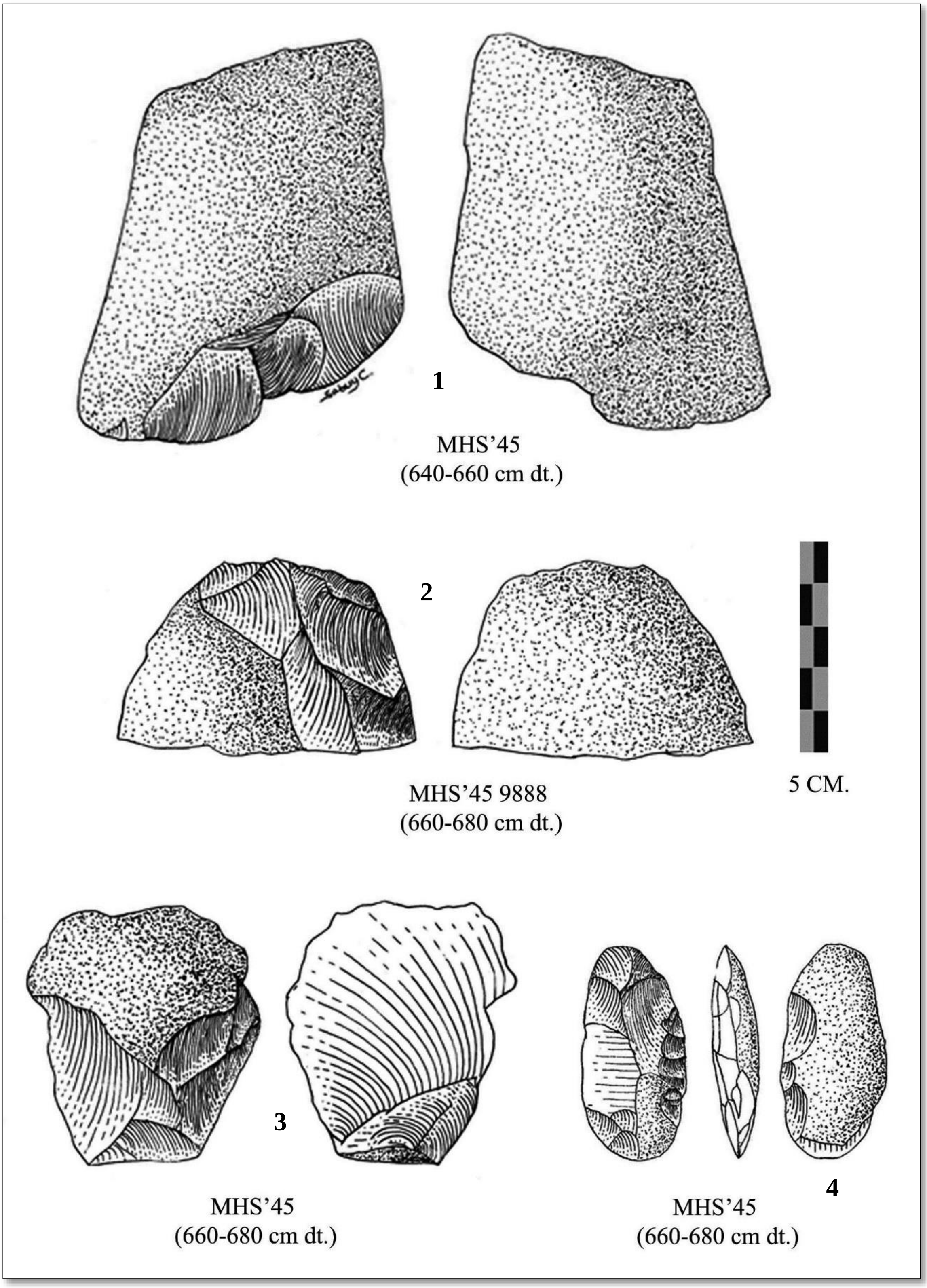


Plate 4.44 Small tools from Tham Lod rockshelter, area 2 sector S21W10 (SEQ 3-4): layer 9 (drawings T. Chitkament). 1) end chopper, 2) ½ small sumatralith, 3) small typical small tool, 4) small typical sumatralith

CHAPTER V

Comments and conclusion

In the present state of knowledge and according to what has been discussed in the first chapter, it appears that the Hoabinhian tools that occur in some parts of Thailand, are not older than the late Pleistocene (Pholgerddee 1981). Since Gorman's excavation at Sprit Cave, in north-western Thailand in the 1970's, the sites of Hoabinhian culture have become better understood (Gorman 1970, 1971,1972; White and Gorman 1979, 2004; Reynolds 1992; Shoocongdej 2002, 2003, 2005, 2006, 2007; Forestier et al. 2006; Marwick 2008; Zeitoun et al. 2008, 2013). Native and foreign researchers excavated several prehistoric sites and recovered large archaeological evidence revealing Hoabinhian cultural assemblages, which have been related with the other regions (Tham Phaa Chan: Gorman 1970; White and Gorman 1979, 2004; Bunnanurag 1988; Obluang: Santoni et al. 1986, 1990; Banyan Valley Cave: Reynolds 1992; Ban Rai and Tham Lod Rockshelter: Shoocongdej 2002, 2003, 2004, 2006, 2007,Treerayapiwat 2005, in North-western Thailand; Khao Talu, Ment and Heap Caves: Pookajorn 1977, 1979, 1984, 1988; Ongbah Cave: Sørensen 1988; Lang Kamnan Cave: Shoocongdej 1991, 1996a, 1996b, 2000, in Western Thailand, and Lang Rongrien: Anderson 1986, 1990 and Moh Khiew: Pookajorn 1991, 1994, 2001, Moser 2001, in Southwestern Thailand). These are indication of the places inhabited by hunter-gatheres, who were making and using a particular type of industry: the Hoabinhian industry.

Archeologists have discovered a plenty of sites related to Hoabinhian culture on the mainland of Southeast Asia and in the island of Sumatra. Although Hoabinhian was discovered and defined in Vietnam, yet, on this matter, Thailand has more evidence of Hoabinhian artefacts and sites than elsewhere.

The site of Tham Lang Rongrien (Anderson 1986, 1990), in south-western Thailand, is of utmost significance with regards to Hoabinhian cultural assemblages. This is because of its chronology (38 ka BP), which is older than the other late Pleistocene sites in Thailand. The lithic artefacts are also of importance; flake tools were recovered in larger quantities than core tools. The Pha Chang Rockshelter near Obluang (Santoni et al. 1986, 1990) is also an early Hoabinhian site in northern Thailand dated at the base of the stratigraphy to 28 ka. Dating was based on fragments of burned bones from this site. Its archaeological remains are homogenous and correspond to only one cultural period. They include mainly bones, shells, core tools, unifacially flaked, and many flakes.

The site of Moh Khiew (Pookajorn 1991,1994, 2001; Auetrakulvit 1995, Morser 2001; Chitkament 2007; Auetrakulvit et al. 2012) is another Hoabinhian site, close to the Lang Rongrien rockshelter (less than 12 km) in south-western Thailand. The main archaeological evidences found are: lithic artefacts, human skeletons, faunal and floral remains, which were associated with different cultural horizons relating to the Hoabinhian. Of these, the most significant are the lithic artefacts, which are well represented in the lower layers. Essentially, there are more flake tools than core tools. Radiocarbon dates from the site reveal that the lower layers are approximately 25 ka BP year old. The stone artefacts, related to the local Hoabinhian culture found from the site are characterized by bifacial adzes. These appear more frequently than the typical Sumatraliths characterizing the Hoabinhian; this may be linked to the raw material (Chitkament 2007). Also, at Khao Toh Chong Rockshelter (Marwick et al. 2011;

Conrad et al. 2013; Van Vlack 2014) in south-western Thailand, less than 5 km from Tham Lang Rongrien, there is a late Pleistocene and Holocene deposit similar to that found at Moh Khiew Rockshelter.

In the Lang Kamnan cave (Shoocongdej 1996, 1996a, 1996b, 2000), in western Thailand, the lithic assemblages are mostly dominated by flakes and core tools which are found to result from an expedient technology; they do not include any sumatraliths, the typical Hoabinhian tools. The first period of occupation of the site belongs to the late Pleistocene (27 ka to 10 ka BP; Shoocongdej 1996, 2000). It is interesting to note that the typical Hoabinhian assemblages could be missing in this area.

Therefore, most of the late Pleistocene sites, as mentioned above, represent the chronological sequences of the Hoabinhian. However, though the techno-typological classification of these assemblages is generally known, no detailed study has been conducted on them.

On the other hand, some sites of early Holocene age have been excavated in different parts of Thailand. For example, Sai-Yok (van Heekeren and Knuth 1967), Khao Talu, Ment and Heap Caves (Pookajorn 1977, 1979, 1984, 1988), Ongbah Cave (Sørensen 1988) in western Thailand; Spirit cave (Gorman 1971, 1971b, 1972), and Ban Rai Rockshelter (Treerayapiwat 1998, 2005, Shoocongdej 2002, 2003, 2007) in north-western Thailand. The ages of all of these sites are estimated to correspond to the boundary of late Pleistocene and early Holocene (12-10 ka BP). The stratigraphic layers are considerably rich with archaeological remains, mainly Hoabinhian tools, faunal (vertebrate and invertebrate), and floral remains. Therefore, this is a significant period during prehistory in Thailand because the Hoabinhian cultural assemblages are more common and this could suggest changes or adaptation in the technology, according to different resources bound to a new cultural and natural environment.

As a consequence of several archeological research projects at Tham Lod Rockshelter in the district of Pang Mapha, Mae Hong Province, north-western Thailand, and as shown by studies on the lithic assemblage it was confirmed that most of the layers belong to the Hoabinhian cultural stage. Because of its well stratified archeological sequence, Tham Lod is a new example of rigorous and intensive prehistoric research in Thailand. The lithic and faunal remains occur by thousands throughout the sequence (late Pleistocene); ceramics and metal items appear in the upper layers (Holocene). Noteworthy of these are a few human burials in the late Pleistocene layers. The chronological sequence ranges from late Pleistocene (35 ka, TL, which is one of the oldest dates for a prehistoric site in this region), to the late Holocene (3000 year BP). The middle Holocene is absent.

This research stemmed out of an interest in the prehistoric people, who lived in north-western Thailand during the late Pleistocene. Archaeological assemblages, lithic industries, faunal and floral remains, as well as the study of the place where these were discovered from different stratigraphic sequences (3 to 10). To know how prehistoric people have produced their varied tool kits, studies of the climate and the adaption of behaviour according to the environmental changes have also been undertaken. The archaeological materials answer the question of cultural behaviour through observed characteristics of the remains. Hence, in the present chapter, the stratigraphic layers of Tham Lod Rockshelter are grouped into different sub-periods based on their cultural relationship as evidenced from the lithic assemblages.

In chapter IV, the analysis of lithic technology, particularly the study of production and use of stone implements of various types has helped in understanding the technical behaviour of prehistoric people living in Tham Lod. In parallel, the primary analysis of mammal remains from areas 1, 2 and 3 of Tham Lod (Amphansri 2004, 2005, 2011; Wattanapituksakul 2006) as well as shell remains (Marwick & Gagan 2011) and palynological remains (Treekanchanawattana and Pumijumnong 2005, 2007) has helped to define the environment and conditions for survival during those periods. Therefore, these archaeological remains are able to answer the vagueness involved in the cultural period, and can reconstruct the paleoenvironment of Tham Lod Rockshelter during late Pleistocene. A discussion about these points follows.

5.1 Summary of analysis of the lithic industry from area 2, sectors S20W10 and S21W10 in Tham Lod Rockshelter

As mentioned in chapter IV, the lithic industry has been classified into different artefacts categories: flakes, small tools/ light-duty tools (<100 mm), large tools/ heavy-duty tools, hammerstones, big fragments, small fragments, and unmodified manuports. Proper cores are so few (7) that they are practically negligible. Altogether, the studied lithic material amounts to 10,740 artefacts, excavated from the stratigraphic layers 3 to 10 of area 2, sectors S20W10 and S21W10 **(Tables 3.4.2.1 & 5.1.1)**.

The beak-up of artefact categories at the site is as follows: flakes (1377=13%), large tools/ heavy-duty tools (411= 4%), small tools/ light-duty tools (393=4%), hammerstones (745=7%), big fragment (319=3%), small fragments (7222=67%) and unmodified manuports (274=3%). It is to be noted that actual tools imply modification of any support, either by retouch (mostly small tools but also some large tools) or by shaping (usually large tools).

Artefact categories	Flakes	Core	Small tools	Large tools	Hammers	Big fragments	Small fragments	Manuports (pebbles & cobbles)	**Total**
Stratigraphic layers	Nb (%)	Nb (%)	Nb (%)	Nb (%)	Nb (%)	Nb (%)	Nb (%)	Nb (%)	N
Layer 3	345 (10)	2	128 (3)	138 (4)	341 (9)	184 (5)	2409 (67)	64 (2)	**3611**
Layer 4	430 (19)	1	121 (5)	79 (4)	231 (10)	85 (4)	1271 (56)	48 (2)	**2266**
Layer 5	151 (22)	0	14 (2)	7 (1)	5 (1)	0	501 (73)	11 (1)	**689**
Layer 6	9 (4)	0	31 (13)	14 (6)	2	0	165 (71)	11 (5)	**232**
Layer 7	89 (7)	2	28 (2)	38 (3)	9 (1)	0	1043 (83)	49 (4)	**1258**
Layer 8	179 (13)	0	43 (3)	60 (5)	73 (5)	25 (2)	961 (70)	30 (2)	**1371**
Layer 9	147 (19)	2	39 (5)	36 (5)	41 (5)	11 (1)	475 (60)	38 (5)	**789**
Layer 10	27 (5)	0	7 (1)	11 (2)	43 (8)	14 (3)	397 (76)	25 (5)	**524**
Total	**1377 (13)**	**7**	**411 (4)**	**383 (3)**	**745 (7)**	**319 (3)**	**7222 (67)**	**276 (3)**	**10740**

Table 5.1.1 Distribution of the main artefact categories in the stratigraphic sequence of area 2, sectors S20W10 and S21W10 of Tham Lod Rockshelter

The layer 3 is the richest in artefacts within the sequence, providing 35%, followed by layer 4 which represents 20%. The other layers are not as rich but it has to be kept in mind that some of them (7 to 5) are present in one sector only (S21W10) and that all layers do not have the same thickness **(Tables 4.2.1 & 5.1.1, figure 5.1.1)**.

The large majority of artefacts are made of gray sandstone (90%) in all the layers, with black sandstone, quartzite, siliceous shale and quartz as complementary raw materials. The main artefact category consists of fragments, especially of small fragments, representing nearly 70% of the whole series. Among them, the flake fragments exceed the amorphous fragments in the sector S21W10 while they are proportionally less in the sector S20W10. They are preponderant in the middle layers, especially the layer 7 (83%) while the lowest value is in the upper layer 4 (56%).

Comparatively the big fragments are somewhat rare. Unbroken flakes account for around 13% of the studied material, but their proportion varies from layer to layer. The real tools (large and small tools) together do not reach 10% except in layer 6 (nearly 20%). The hammerstones are in similar proportions (around 7%) except in the layer 6 where they are infrequent. It is interesting to note that cores are almost absent in these sectors **(Table 5.1.1, figure 5.1.1)**.

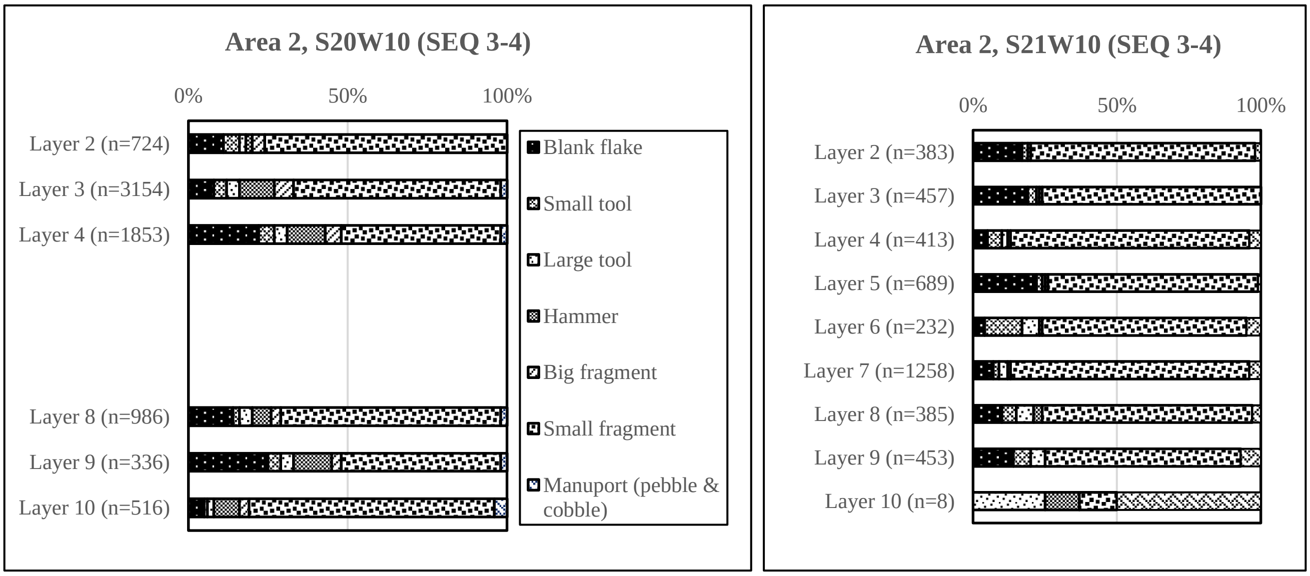


Figure 5.1.1 Distribution of the main artefact categories across the stratigraphic sequence of Tham Lod Rockshelter in area 2, sectors S20W10 and S21W10

The principle tool of this particular lithic industry, the “sumatraliths” are overwhelmingly present at Tham Lod, with the radiometric dates being among the oldest in Thailand (and Southeast Asia). The typical sumatraliths, the signature of the Hoabinhian technical tradition, are conspicuous in the layer 4. In the sequence they are mainly represented in the upper layers (4 and 3) and gradually decrease in the middle and the lower layers; they seem to be absent in the bottom layer 10. Conversely, the cobble tools are almost exclusively choppers in the lower layers 10 to 8. Typical sumatraliths are associated with partial sumatraliths (not shaped all around), especially in the layer 6. The scrapers are persistent in their proportions; they are dominant over other small tool types. The denticulates, pointed tools and atypical small tools are rare (less than 10% of the studied material) **(Tables 4.2.2 & 5.1.2, figures 4.2.4 & 5.1.2)**.

The lithic assemblage from Tham Lod Rockshelter, area 2, sectors S20W10 and S21W10, has been analyzed in details. Each artifact category is described here below.

1) Blank flakes

A total of 1377 (13%) flakes are present in the studied sectors. Their proportion is particularly high in the layer 5 (151/689: 22%), followed by the layers 4 and 9 (nearly 20%). The lowest layer 6 is by far the poorest in the sector S21W10 (9 artefacts only) while it quite rich (411 artefacts) in the sector S20W10, further away from the cliff towards north. Large majority of flakes are on gray sandstone (more than 90%). However, in the lower layers, especially in the bottom layer 10, the rocks are slightly more diversified with the use of the black sandstone (6/127: 22%; **Table 4.3.2**).

The average measurements of the flakes are rather homogenous along the sequence, with a value of 42 mm in average length, around 40 mm in average width and 12 mm in thickness **(Table 4.3.3)**. The longest flakes occur in the bottom layer 10 (47 mm in average) and the smallest ones are in the middle layer 5 (36 mm in average). In the other layers, they vary between 39 and 45 mm. The flakes are fairly short, not elongated either possibly due to the quality of the rock available around Tham Lod Rockshelter; or due to the process of flake production; or considering the near absence of core, many of the flakes could also be produced by the shaping of large tools **(figures 4.3.5 & 4.3.6)**.

Most of the butts are totally cortical, especially in the upper and middle layers with proportions reaching two-third of the flake assemblage, while they represent only the half in the lower layers 10 to 8. Next in frequency are the butts without cortex representing about 30% in the lower layers, slightly less in the layers above. Partly cortical platforms are not so common (10 to 20%) **(Table 4.3.5, figure 4.3.7)**.

Platforms are usually plane in shape. Bifacetted / dihedral platforms occur on 10 to 15% of the flakes **(Table 4.3.6)**. Linear or punctiform platforms resulting from strokes applied on the ridge or the corner of the cores or large tools vary considerably from layer to layer and from sector to sector. They may be linked to the shaping or re-sharpening of the large tools (stroke applied on the edge and not on a surface).

The flakes devoid of cortex on their dorsal face are the majority (50 to 60%) and they are accompanied by flakes with little cortex (20 to 30%; **Table 4.3.8, figure 4.3.10**). In the layer 5 which is the richest in flakes of the sector S21W10, these two groups reach 90%. Flakes with a totally cortical dorsal face are very few in the sector S21W10 while they represent 10 to 15% in the adjoining northern sector **(see in the appendix A)**. They correspond to the first state of core reduction or tool shaping.

Considering that the large tools provided about 10 flakes during their shaping (3 to 5 for the choppers, 10 to 15 for the sumatraliths), this proportion of nearly 10% of cortical flakes suggests that the initial stage of tool shaping was carried out in the site itself. For production of flakes from cobbles, if at all this activity of proper debitage occurred at Tham Lod, the proportion of cortical flakes would be approximately the same. Marwick (2008) mainly obtained 1 to 19 flakes per core and Jeremie and Vacher (1992) in their experimental production of sumatraliths ("*haches*" = axes) obtained 10.5% of entirely cortical flakes. In the experiment conducted in the context of the present research, 260 flakes were produced by the shaping of 30 tools representative of the lithic assemblage from Tham Lod Rockshelter (see below; **Appendix B: Table 8**). For each tool there must be one fully cortical flake and therefore the proportion of such flakes is 11.5% (30/260). However, variations in the two sectors suggest that the activities were not the same in the different sectors of the site.

The scar pattern on the dorsal face of the flakes is mostly unipolar (50 to 70% without considering the undetermined items). Otherwise they are bipolar opposite (10 to 20%) and less frequently orthogonal or multidirectional **(Table 4.3.9, figure 4.3.11)**. A convergent pattern is noted in layer 4 of sector S20W10 (37/268=14%) and it may be linked to the higher frequency of typical sumatraliths, shaped all around. Generally, the unipolar pattern is found as a result of reducing cores from one single striking platform or by shaping choppers. There are usually two scars on the dorsal face of the flakes, otherwise 1 or 3 scars, rarely more except in the layer 4 as well as in layer 3. This suggests a simple reduction strategy, probably corresponding only to the shaping of the large tools **(Table 4.3.10)**.

The edges are mostly "acute" (30°-60°) on the lateral and distal sides of the flakes. They are "very acute" in more than 25-30% of the cases in the upper layers 3 and 4, especially on the distal position (layer 3, 35%; layer 4, 39%; **Tables 4.3.15 & 4.3.16**). The angle of the proximal side is of course more open since it corresponds to the striking platform. It is usually "steep-inverse" (100°-120°) or "steep" (80°-100°; **Table 4.3.17**).

2) General distribution of large and small tools

As described in chapter IV, the actual tools have arbitrarily been classified into large tools (heavy-duty tools, often called "core tools") and small tools (light-duty tools). The arbitrary boundary between both groups is 10 cm for the length (following Carbonell et al. 1999, in Rodriguez 2004; Kleindienst 1962). The proportion of large tools and small tools is rather stable along the stratigraphy. A total of 383 large tools (3% of the entire lithic assemblage, 48% of the tools) is found in area 2, sectors S20W10 and S21W10. They comprise two main groups of tools: the choppers and the sumatraliths **(Table 4.4.2, figure 4.4.1)**. The layer 4 is remarkable in this respect because the sumatralith group is more in quantity than the chopper group while in the other layers this is reverse. It is interesting to see that in the upper layer 3, the chopper group is still well represented **(Table 5.1.2)**.
Small tools are slightly more in number than the large tools with a total of 411 (4% of the total number of artefacts, 52% of the tools) in the studied sectors **(Table 4.5.1.2)**. All types of small tools are usually measuring less than 10 cm. It is to be noted that many sumatraliths occur among the small tools; these will be analyzed together with the larger ones, due to their obvious typological continuity, whether longer or smaller than 10 cm **(Table 5.1.2)**.

Actual tools (large and small)	Chopper	Sumatralith	Partial sumatralith	Scraper	Other small tool	**Total**
Stratigraphic layers	Nb (%)	Nb (%)	Nb (%)	Nb (%)	Nb (%)	N
Layer 3	86 (32)	37 (14)	57 (21)	53 (20)	33 (12)	**266**
Layer 4	33 (16)	41 (20)	34 (17)	56 (28)	36 (18)	**200**
Layer 5	5 (24)	4 (19)	3	7 (33)	2	**21**
Layer 6	10 (22)	10 (22)	13 (29)	8 (18)	4	**45**
Layer 7	31 (47)	6 (9)	7 (11)	18 (27)	4	**66**
Layer 8	49 (47)	11 (11)	7 (7)	23 (22)	13 (13)	**103**
Layer 9	29 (39)	8 (11)	10 (13)	19 (25)	9 (13)	**75**
Layer 10	11 (61)	0	0	4 (22)	3	**18**
Total	**254**	**177**	**131**	**188**	**104**	**794**

Table 5.1.2 Distribution of the main tool types (large & small tools) in the stratigraphic sequence of sectors S20W10 and S21W10, area 2 of Tham Lod Rockshelter

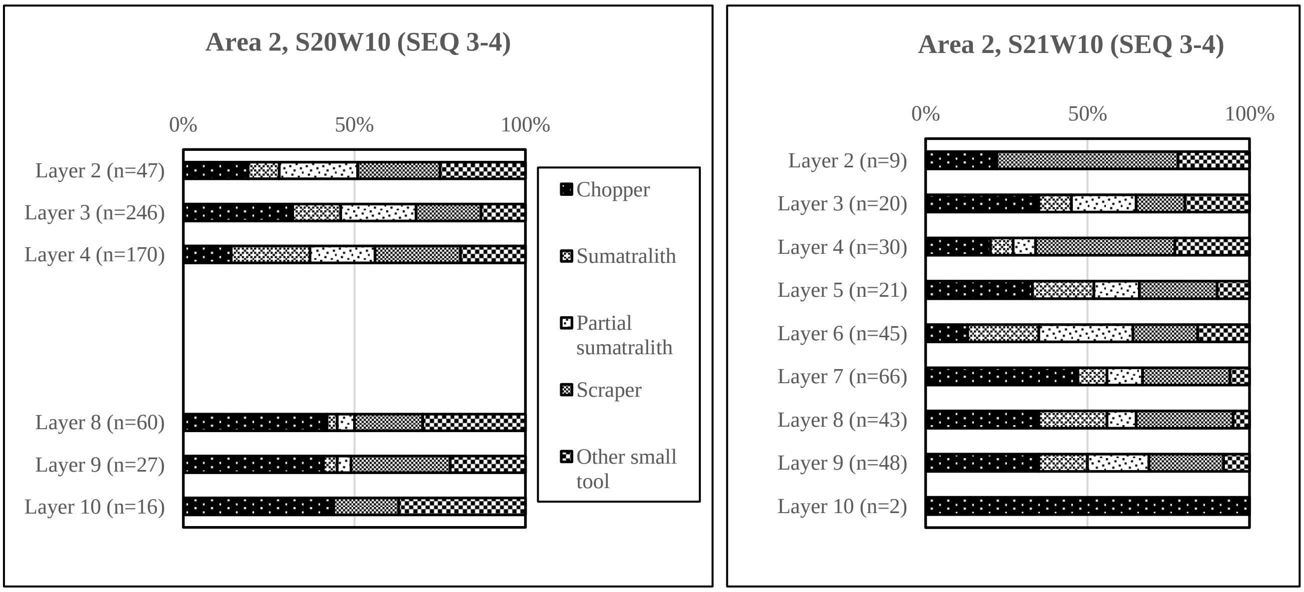


Figure 5.1.2 Distribution of the main tool types (large tools & small tools) across the stratigraphic sequence of Tham Lod Rockshelter in area 2, sectors S20W10 and S21W10

Large tools	End chopper	Side chopper	Other choppers	Suma-tralith	Partial sumatralith (unifacial)	Partial sumatralith (bifacial)	Discoid	**Total**
Stratigraphic layers	Nb (%)	Nb (%)	Nb (%)	Nb (%)	Nb (%)	Nb (%)	Nb (%)	N
Layer 3	40 (29)	13 (9)	33 (24)	26 (19)	20 (15)	6 (4)	0	**138**
Layer 4	12 (15)	12 (15)	9 (11)	36 (46)	5 (6)	3	2	**79**
Layer 5	3	2	0	2	0	0	0	**7**
Layer 6	3	2	5 (36)	3	1	0	0	**14**
Layer 7	20 (53)	3	8 (21)	5 (13)	2	0	0	**38**
Layer 8	8 (13)	17 (28)	24 (40)	7 (12)	3	1	0	**60**
Layer 9	13 (36)	6 (16)	10 (28)	5 (14)	1	0	1	**36**
Layer 10	3	1	7 (64)	0	0	0	0	**11**
Total	**102**	**56**	**96**	**84**	**32**	**10**	**0**	**383**

Table 5.1.3 Distribution of the large tool/ heavy-duty tool types in the stratigraphic sequence of sectors S20W10 & S21W10, area 2 of Tham Lod Rockshelter

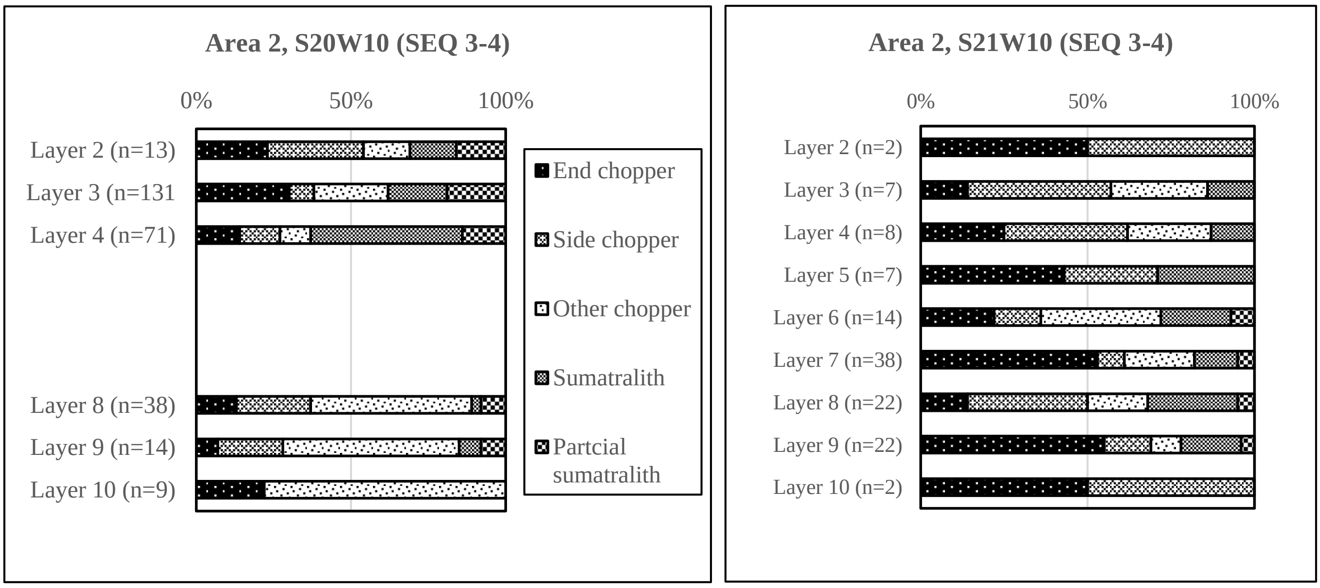


Figure 5.1.3 Distribution of the main large tool types across the stratigraphic sequence of Tham Lod Rockshelter in area 2, sectors S20W10 and S21W10

3) Choppers (Large tools)

The choppers belong to the large tool category (measuring more than 10 cm). Their total number in the studied sectors is 254. They represent about one third of the whole series of large and small tools; in the lower half of the sequence (layers 10 to 7) they are more than 40% while in the upper part (layers 6 to 3) they are less than 32% **(Tables 4.4.1.1 & 5.1.3)**. Variations between both sectors also occur. The large tools are maximum in the bottom layer 10, where they represent the only type of heavy-duty tools, and their minimal frequency occurs in the layer 4 (41%). In the other layers, their frequency ranges between 62 and 80%.

Three main categories of choppers are distinguished **(Table 5.1.3, figure 5.1.3)**: end chopper, side chopper and a group of “other chopper” including various types represented by very few examples in the studied series. End choppers are more common in the sector S21W10 while “other choppers” and side choppers are more common in the sector S20W10, at least at the base of the sequence **(figure 5.1.2 and see in the appendix A)**.

Choppers are mostly in gray sandstone (more than 90%) in all the layers, except the lower layer, where the raw materials are more diversified **(Table 4.4.1.2)**. The principle supports are broken cobbles (77%) or whole cobbles (47/257: 19%); some flakes, fragments or broken boulders were also used for shaping the choppers. Masses range between 201 and 1000 g and the class where most of the choppers cluster is between 401 and 600g, especially in the layers 3, 4 and 8 **(Table 4.4.1.3)**.

3.1 End choppers

Most of the choppers are end chopper (102: 27% of the large tool, 40% of the choppers; **Table 5.1.3, figure 5.1.3**). The large majority of these tools, in all layers, are on gray sandstone (90%) and are made on broken cobbles (52/102: 51%) or cobble fragments (29/102: 28%). The other supports are whole cobbles, split cobbles, indeterminate cobbles, flakes or fragments **(Table 4.4.1.1.5)**. Masses are clustered between 401 to 600 g and the average dimensions are: length 134 mm, width 91 and thickness 55 mm **(Tables 4.4.1.1.4 & 4.4.1.1.3)**. End choppers are almost always unifacial, by definition, but there are also a few bifacial specimens. The general morphology is more commonly irregular or oval for the frontal and transversal views. The delineation of the edges is often incurvated and non-symmetrical in sagittal view **(Tables 4.4.1.1.6 & 4.4.1.1.7)**.

The upper face usually retains a large patch of cortex (“cortical dominant”: 62%). end choppers are usually shaped by 2 and 3 removals, but this number can reach 10 and even more; the removals are mostly unipolar unidirectional, around 70% of them fit to this pattern **(Tables 4.4.1.1.8, 4.4.1.1.9 & 4.4.1.1.10)**. The length of the longest removals on the upper face varies within a large range of values from 10 to 80 mm, but it shows a regular normal distribution with an average around 40 mm **(Table 4.4.1.1.12)** quite close to the average length of the blank flakes (42 mm). The shaping is mostly marginal (65%). The lower face (flattest and therefore usually not shaped) is mostly totally cortical (55%). Hardly 15% of the end choppers bear some removals on the lower face, usually 1 or 2 removals. These are often unidirectional (80%), they remain marginal (93%) and the longest ones measure between 21 and 30 mm.

The nature of both lateral edges of the end choppers is similar; it is often cortical or shaped (maybe not intentionally) by a fracture. These edges often have very open angles (80°-100°), as expected for cortical sides. In distal position (narrowest end), where it is shaped in three fourth of the cases, the edge is rather sharp or medium (30°-60°). In proximal position (widest end) the edge is shaped in one fourth of the cases, especially in the middle layers and in the layer 4, with a medium or sometimes acute angle **(Tables 4.4.1.1.18, 4.4.1.1.19 & 4.4.1.1.20)**. Of course, in most of the cases, edges are unifacially shaped.

3.2 Side choppers

The side choppers are 56 in total (15% of the large tools, one fourth of the choppers; **Table 5.1.3, figure 5.1.3**). Their attributes are rather similar to those of the end choppers but their cutting edge is almost straight, located on one side of the tool while the opposite side is a cortical butt. The side choppers are made of gray sandstone in 93% of the case **(Table 4.4.1.2.2)** and this is rather similar to the end choppers. The main supports are broken cobbles (31/56: 55%) or cobble fragments (12/56: 22%) while whole cobbles are less frequent and split cobbles exceptional **(Table 4.4.1.2.5)**. Masses are clearly bimodal with a main group between 201-1200 g, around a mode at 400-600 g, and a smaller group of heavy tools, weighing more than 1400 g. Their average dimensions are slightly shorter and wider than those of the end choppers: average length 133 mm, width 89 mm and thickness 50 mm. They are less elongated **(Table 4.4.1.2.3, figures 4.4.1.2.4 & 4.4.1.2.5)**.

The general morphology of side choppers is rather identical to those of the choppers. The irregular shape is more frequent than the other shapes for the frontal view, the trapezoidal shape is globally preponderant for the transversal view **(Tables 4.4.1.2.6 & 4.4.1.2.7)**.

Their upper and lower faces are somewhat similar to those of the end choppers, as far as the cortex is concerned. However, the number of removals shaping the upper face makes up two groups of choppers, a first one with 1 to 3 removals, like the end choppers, and the second one with about 6 removals. The length of the longest removals on the upper face varies between 10 and 93 mm, and it seems to be slightly bimodal, with a concentration between 21 and 40 mm and another one at 51-60 mm. All together these dimensions fit to those of the blank flakes and confirm that most of the flakes are produced by the shaping of the large tools, at least the choppers.

The side choppers are shaped on the right edge and on the left edge in approximately equal frequencies (**Table 4.4.1.2.21**) and the angles of the shaped edges are comparable on both the sides. They are mostly medium and secondarily acute **(Table 4.4.1.2.18)**. The shaping of the lateral edges sometimes extends on the proximal or distal edges. Anyway, proximal ends are often cortical, with of course an open angle, while the distal edges, where fractures are common, tend to be more medium or even acute **(Tables 4.4.1.2.19, 4.4.1.2.20 & 4.4.1.2.21)**.

3.3 Other choppers

Various types of choppers are combined in these groups: corner chopper, double chopper, nosed chopper, multiple chopper, giant chopper and horsehoof, totalizing 96 items (25% of the large tools; **Tables 4.4.1.3.1 & 5.1.3**). Their frequency is quite variable not only between the layers, but also between the sectors: they are well represented in the sector S20W10 in comparison S21W10, closer to the cliff **(see in the appendix A)**. The large majority of these tools are in gray sandstone (nearly 90% in the whole sequence); this is similar to the composition of the end and side choppers, and of the lithic assemblage in general. They are principally made on broken cobbles (around 60%) and secondarily on cobble fragments or whole cobbles by unifacial shaping **(Table 4.4.1.3.6)**. The classes are clustered in mass between 201 and 800 g. Their average dimensions are consistent with those of the end and side choppers: 130 mm in length, 86 mm in width and 56 mm in thickness **(Table 4.4.1.3.4, figures 4.4.1.3.6 & 4.4.1.3.7)**. The general morphology often exhibits irregular shape in frontal view, globally with the same frequency as the end choppers but less than the side choppers. On the other hand, for the transversal view, the triangular shape is more common, along with trapezoidal shape **(Tables 4.4.1.3.7 & 4.4.1.3.8)**.

The upper face is mostly “cortical dominant” (nearly 60%). The average number of removals shaping these tools is around 5.6 for the whole stratigraphic sequence and the shaping is mostly marginal (50%). The length of longest removals ranges from 6 to 97 mm, but the most significant values are between 31 and 50 mm.

As for the lower face, it is often totally cortical (nearly 55%). Some 20% of the other choppers are shaped on the lower face, where usually 1 or 2 removals can be observed. This shaping remains marginal, with the length of the longest removals measuring less than 40 mm in most of cases.

The edge angles are rather open (80°-100°) on the lateral edges, medium to open (60°-80°) on the distal edge and proximal edge is usually cortical **(Tables 4.4.1.3.19, 4.4.1.3.20 & 4.4.1.3.21)**.

4) Small tools

The small tools or light-duty tools are 411 in total and all of them are usually measuring less than 10 cm. Their proportion (less than 5%) is rather similar along the stratigraphy when the whole assemblages are considered **(Table 4.5.1.2)**. When referring to the tools only, their frequency increases in the layer 4 **(Table 5.1.4 & figure 5.1.4)**. Small tools are comprised of several types: scrapers, denticulates, pointed or convergent tools, atypical small tools, unifacial discoid, small sumatraliths (typical and partial, unifacial and bifacial). The latter, both typical and partial, are numbered in this group but were considered along with their larger counterparts (above 10 cm in length) for the detailed analysis. It is to be noted that the group of small tools designed as “atypical small tools”, bear a few apparently international retouches, but they are impossible to classify into any particular tool type, even partial scarper to which they are akin.

Small tools	Scraper	Denti-culate	Pointed tool	Atypical small tool	Small suma-tralith	Unifacial discoid	Small partial sumatralith (unifacial)	Small partial sumatralith (bifacial)	**Total**
Stratigraphic layers	Nb (%)	Nb (%)	Nb (%)	Nb (%)	Nb (%)	Nb (%)	Nb (%)	Nb (%)	N
Layer 3	53 (41)	15 (12)	5 (4)	13 (10)	11 (9)	2 (1)	28 (22)	1	**128**
Layer 4	56 (46)	12 (10)	11 (9)	13 (11)	5 (4)	0	22 (18)	2	**121**
Layer 5	7 (50)	0	0	2	2	0	3	0	**14**
Layer 6	8 (26)	0	1	3	7 (23)	0	11 (35)	1	**31**
Layer 7	18 (64)	1	1	2	1	0	5 (18)	0	**28**
Layer 8	23 (54)	2	1	10 (23)	4	0	3	0	**43**
Layer 9	19 (49)	3	2	4	3	0	8 (20)	0	**39**
Layer 10	4	1	2	0	0	0	0	0	**7**
Total	**188**	**34**	**23**	**47**	**33**	**2**	**80**	**4**	**411**

Table 5.1.4 Distribution of the light –duty tool types in the stratigraphic sequence of sectors S20W10 & S21W10, area 2 of Tham Lod Rockshelter

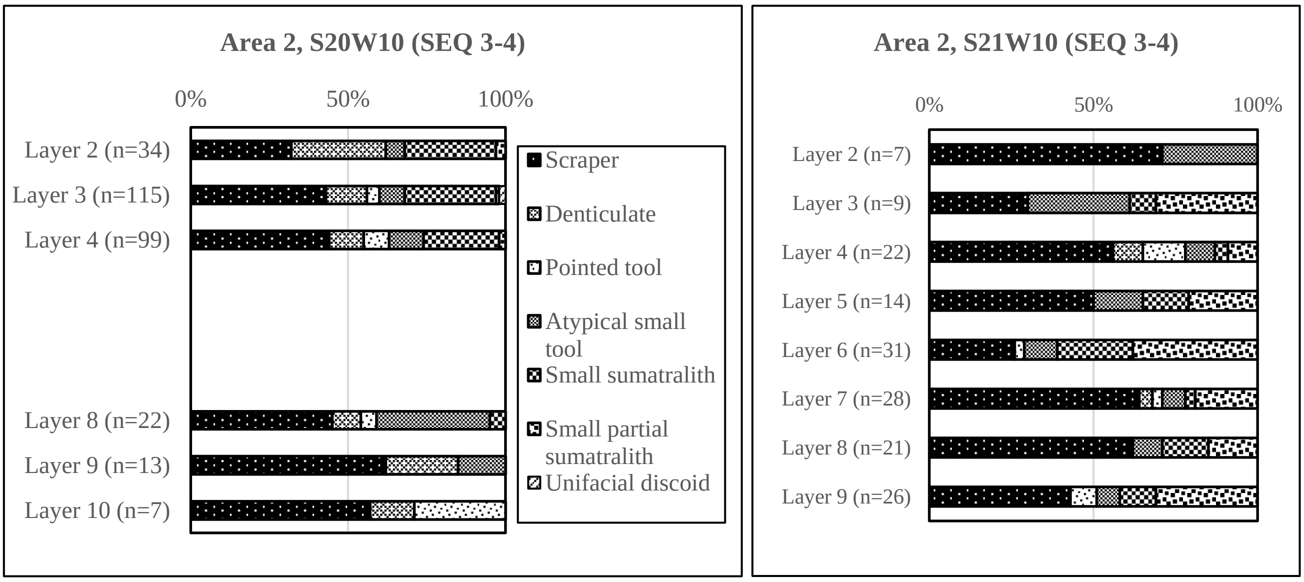


Figure 5.1.4 Distribution of the main small tool types across the stratigraphic sequence of Tham Lod Rockshelter in area 2, sectors S20W10 (SEQ 3-4) and S21W10 (SEQ 3-4)

4.1 Scrapers

The large majority of the small tools are scarpers, with a total number of 188. They represent 20 to 25% of all the tools (large and small) therefore showing a rather constant frequency (**Tables 4.2.2 & 5.1.4**) but they show noticeable variations from 25 to 50% between layers with regard to small tools only. Generally, they are comprised of various types: double scraper, steep scraper, nosed scraper, multiple scraper etc., but two main types such as the end and side scrapers are significant.

Several types of raw materials were identified among the scrapers: gray sandstone, black sandstone, quartzite, mudstone, siliceous shale, haematite and phtanite (only one specimen of each of the latter two rocks). The large majority of them are made on gray sandstone, nearly 90% in all the layers, maybe except in the bottom layer 10 (only 2/4; **Table 4.5.2.3**). Most of them are made on broken cobbles (68/188: 36%), especially in the layer 8 (52%), followed by cobble fragments (45/188: nearly 25%). The average dimensions are quite small, half of the choppers: length 77 mm, width 63 mm and thickness 36 mm but the distribution of length and width are slightly bimodal (main mode at 90-100 mm and secondary mode at 70-80 mm; **Table 4.5.2.4, figure 4.5.2.4**). The high concentration of scrapers close to 100 mm long, which is the maximal length for the so-called small tools or light-duty tools, actually questions the validity of this arbitrary limit between large and small tools. These biggest scrapers are probably in continuity with the choppers.

Scrapers mostly weigh between 100 and 300 g **(Table 2.5.2.5, figure 2.5.2.7)**. Their outline (frontal view) is usually trapezoidal and irregular (24 and 27%) and their transversal view trapezoidal (33%). The delineation of the edges is more incurvated than straight and it is sinuous in sagittal view; these tools are mostly non symmetrical **(Tables 2.5.2.7 & 2.5.2.8)**.

The end scrapers and side scrapers are significant types in the studied sectors, and could be described in details as follows:

4.1.1 End scrapers

Half of the 188 scrapers are end scrapers (94/188: 50%). Most of them are “cortical dominant” on their upper face, amounting to 61% (57/94; **Table 4.5.2.9**). Their shaping is noticeably limited to 2 to 3 removals (excluding the smaller retouch), mostly unipolar unidirectional (78%; **Table 4.5.2.13**). The maximal longest removal is between 21 and 30 mm on an average **(Table 4.5.2.15)**. On the lower face, they are more “totally cortical” (47%) and the specimens shaped on the lower face usually show 2 removals. The longest removals have an average length between 11 and 20 mm (**Tables 4.5.2.10, 4.5.2.12 & 4.5.2.16)**.

End scrapers are mostly unifacially shaped or retouched on their distal edge (narrowest) but some of them are so on the proximal **(Tables 4.5.2.18 & 4.5.2.19)**. The distal edges, when shaped or retouched, are markedly acute or medium angled. In proximal position the shaped edges are rather medium angled **(Table 4.5.2.22)**. The lateral edges are mostly medium to open angled (60°-80°) and they are usually cortical or made up by a fracture **(Table 4.5.2.20)**.

4.1.2 Side scrapers

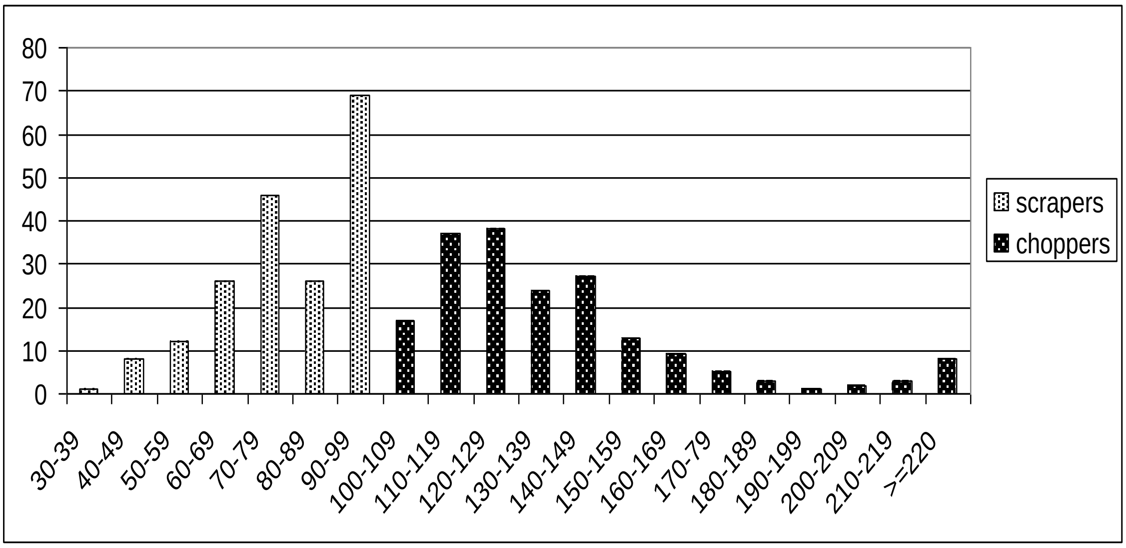
With a total 33 artefacts, the side scrapers represent about 18% of the scrapers in all the layers. They are mostly "cortical dominant" on the upper face (46%: 15/33; **Table 4.5.2.23**) and rather totally cortical on the lower (flattest) face (18/33: 55%; **Table 4.5.2.24**). The side scrapers are usually shaped by 2 removals (excluding retouch) in the lower and middle layers and by more than 4 removals in the upper layers 4 and 3 (Table 4.5.2.25). The length of the longest removal is between 21 and 30 mm **(Table 4.5.2.29)**.

Two third of the side scrapers are shaped or retouched on their right edge (22/33) and the difference with the left edges (one third only) is statistically significant. Angles of the lateral edges whether shaped or not, are mostly sharp to medium (30°-60°), but shaping slightly improves the sharpness **(Table 4.5.2.34)**. Distal and proximal edges are usually open (80°-100°) as the distal edges are mostly cortical and the proximal ones mostly made by a fracture **(Tables 4.5.2.35 & 4.5.2.36)**.

4.1.3 Comparison between scrapers and choppers

Several characters of the scrapers recall those of the choppers and therefore it is interesting to discuss their similarities and differences. Their supports are mainly broken cobbles, and secondarily whole cobbles; split cobbles occur among the scrapers but are very few among the choppers. The proportion of end-tools is much higher than side-tools: end choppers are twice more than side choppers and end scrapers trice more than side scrapers. Dimensions are of course different as scrapers are small tools (< 100 mm) and choppers are large tools (> 100 mm), but the distribution of their length clearly indicates continuity between both types: it is represented by histograms suggesting a normal distribution (unimodal and symmetrical), at least when class intervals are of 20 mm instead of 10 mm (maybe too accurate for the size of the samples; **figure 5.1.5**).

From this point of view, the scrapers and choppers can be considered as forming together a homogeneous group of tools, except in the lower layer 10 where all the four scrapers are made on flake or fragment. In this group of tools, the average length is 110 mm and the average thickness 46 mm for the whole stratigraphic sequence, but there are variations between layers and these measurements decrease from bottom to top of the sequence.



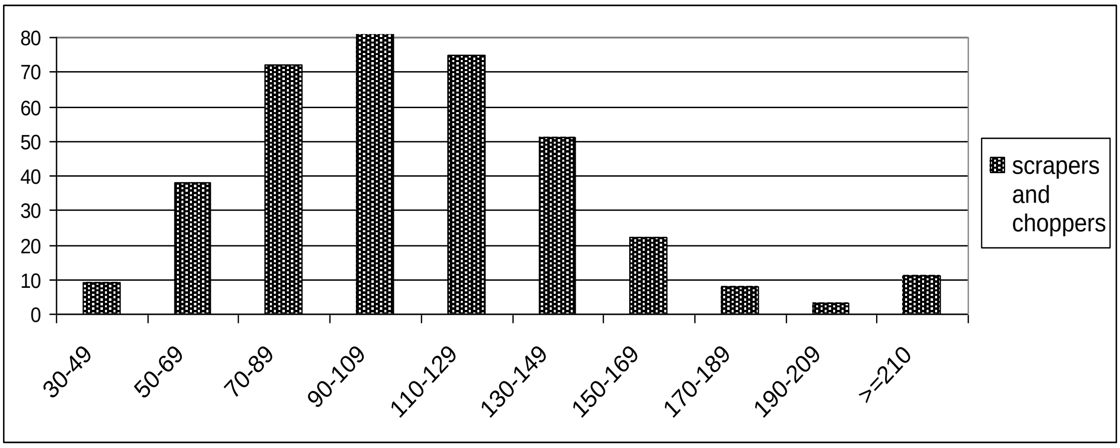


Figure 5.1.5 Distribution of the length (in mm) of scrapers and choppers from Tham Lod Rockshelter in area 2, sectors S20W10 (SEQ 3-4) and S21W10 (SEQ 3-4); up: histogram for intervals of 10 mm; down: histogram for intervals of 20 mm.

4.2 Denticulates

Denticulates (34 in total) are significantly present in the upper layers 3 and 4 only; in the other layers they are not more than 3 **(Tables 4.2.2, 5.1.4 & figure 5.1.4)**. The large majority of them are in gray sandstone and made on broken cobbles (14/34: 41%); flakes (8/34: 23%) are especially used as support in the lower layers 10 to 8. By their weight, denticulates are comparable to atypical small tools, and half of them weigh less than 100 g **(Table 4.5.3.3, figure 4.5.3.6)**. The average dimensions of denticulates are a little shorter than those of the scrapers, but bigger than the atypical small tools (74 mm in average length, 49 mm in the average width and 29 mm in the average thickness). Their general morphology is often irregular in frontal view and triangular for the transversal view. They are always unifacial.

The upper face is mostly "cortical dominant" (47%) such as those of all the tools, they are shaped by 4 removals (nearly 25%) and mostly unipolar unidirectional (70%). The longest removals have an average length around 11 and 20 mm **(Table 4.5.3.13)**. On the lower face, they are mostly "totally-cortical" **(Table 4.5.3.8)**.

Denticulates are mostly shaped or retouched on their distal edge (two third of them), and secondarily on any of the other three edges in approximately equal frequency. These features may be related to the nature of the edges, which is more often a fracture for the lateral and proximal edges **(Tables 4.5.3.15 & 4.5.3.17)**. Therefore, half of the distal edges are acute (30°-60); the right edges seem to be slightly more acute than the left edges **(Table 4.5.3.18)**.

4.3 Pointed tools

The pointed tools (n=23) are even less frequent than the denticulates (**Tables 4.2.2, 5.1.4, figure 5.1.4**). They are mainly made on gray sandstone (78%) but other raw materials like black sandstone and siliceous shale also occur in the sector S20W10. Masses are clustered between 101 and 200 g and average sizes are quite similar to those of other small tools groups (76 mm in length, 48 mm in width and 31 mm in thickness; **Table 4.5.4.3, figures 4.5.4.4 & 4.5.4.5**). The principle supports are broken cobbles (35%) and broken fragments or broken pebbles. Their morphology is trapezoidal in frontal and transversal views, like the other small tools.

More than 50% of pointed tools are "cortical dominant" on the upper face and on the lower face mostly "non-cortical" (43%: 10/23). They are mainly shaped by 2 removals (30%). The length of the longest removal is between 21 and 30 mm. The lateral edges are mostly made up by a fracture and the proximal ones are either cortical or made by facture **(Tables 4.5.4.16 & 4.5.4.18)**.

The point is usually in distal position, with rather acute angles. Lateral edges are somewhat more open (80°-100°) while the proximal edge are medium angled (60°-80°).

4.4 Atypical small tools

Atypical small tools are roughly shaped blanks that cannot be called scrapers or notches. They show little modification, but apparently intentional rather than accidental. They are almost as rare as the previous types (47: 11%) except in the lower layer 8 (10/43: 23%; **Table 5.1.4**). Many are in gray sandstone in all the layers, nearly 95% (44/47) along with one or two specimens in black sandstone and siliceous shale **(Table 4.5.5.2)**. Their main supports are broken cobbles (32%) and flakes (9/47: 19%) besides pebble fragments (6/47: 13%).

Their mass is mostly less than 100 g and sizes are rather smaller than for other small tools: length 69 mm, width 49 mm and thickness 27 mm **(Tables 4.5.5.3 & 4.5.5.4)**. The general morphology is preponderantly trapezoidal in shape for the frontal and transversal views.

The upper face of the atypical small tools is markedly "cortical dominant" (40%) and the lower face is either non-cortical or totally cortical. Shaping usually results from 2 removals. The longest length is maximal between 11 and 40 mm., for 34-36%. The shaping of tools is often made with 1 or 2 removals, of which the longest length is less than 10 mm.

The lateral and distal edges are generally unifacially (but partially) retouched, while fractures occur on the proximal edge. The edges are mostly sharp to medium (30°-60°) on the lateral and distal edges, essentially medium to open (60°-80°) on the proximal edge **(Tables 4.5.5.19, 4.5.5.20 & 4.5.5.21)**.

5) Sumatraliths (large & small tools)

5.1 Typical sumatraliths

Typical sumatraliths number 117 in the studied sectors of Tham Lod, representing 21% of whole tool group. This tool type, specific of Hoabinhian lithic assemblages, is commonly made on oval or almond shaped, rather flat cobbles, with removals all around the upper face forming the working edge. As it corresponds to a remarkable tool type, it appeared irrelevant to separate the small specimens from the large ones. However, nearly 30% of the sumatraliths from Tham Lod belong to the small tool group **(Table 4.6.1.1)**.

Their maximal frequency occurs in the layer 4 (41/200: 20%) and also in the middle layers 5 and 6 (around 20% keeping in mind the small amount of specimens, thus lacking statistical significance). In the lower layers, this tool type accounts for about 10% of the tools, except in the lowest layer 10 where it is absent, and in the upper layer 3 around 15%. Their preponderant raw material is the gray sandstone (95%). Most of them are made on whole cobbles (65/117: 55%) or indeterminate cobbles (21/117: 18%) and are mostly unifacially shaped. Masses range between less than 200 and more than 1400 g, but they are concentrated between 201 and 600 g, mainly in the upper layers 3 to 4. Their average dimensions are: length is 113 mm, width 72 mm and thickness 38 mm **(Table 4.6.2.3, figures 4.6.2.4 & 4.6.2.5)**. The typical sumatraliths are therefore smaller than choppers, with a ratio length/width similar to that of the end choppers but a ratio width/thickness close to that of the side choppers. When compared to the group of choppers and scrapers together, the sumatraliths show about the same average length but they are 5 mm thinner (in average for all the layers). The frontal view (contour) is mostly oval, especially the upper layers (about 84-88%); the transversal view is more often trapezoidal (nearly 30%), especially in the lower layer 8 (73%). The delineation of the edges is often incurvated and non-symmetrical in sagittal view.

The upper face of typical sumatraliths is as often “non-cortical” and “non-cortical dominant”: 36% (42/117) and usually shaped by more than 10 removals in “convergent” direction (76%). The longest removals have an average length around 31-40 mm **(Table 4.6.2.14)**. Conversely, the lower face is mostly “totally cortical” (around 65%). A few sumatraliths (6/117: 5%) also have 1 removal on the lower face, and the longest removal is between 10 and 20 mm in most of cases **(Tables 4.6.2.11 & 4.6.2.15)**.

The angle of edges is rather sharp to medium (30°-60°) on the lateral and distal position, except in the lower layers 9 and 8 where they are often open angled **(Tables 4.6.2.19 & 4.6.2.20)**. The distal edges are more often acute than the other edges.

5.2 Partial sumatraliths

These tools resemble the sumatraliths but are not shaped all around and, thus, are not typical. They are termed "partial sumatralith" (sumatralith partly shaped), a few of them being bifacially shaped. Like the typical specimens, the small and large tools of this group have been studied together. They are comprised of several sub-groups of tools: ½ sumatraliths, ¾ sumatraliths, partly unifacial, partly bifacial and unifacial discoid. They amount to 131 (15% of all the tools). They are quite frequent in the layer 6 (nearly 30%) where they rather belong to the group of small tools, followed by layer 3 and then layer 4. In the lower layers, their frequency is below 15% with regard to all the tools **(Tables 4.2.2 & 4.6.3.2)**. The principal raw materials are gray sandstone, around 96%, and this is equally frequent as in proportions of typical sumatraliths, along with choppers and scrapers. Their supports are made on broken cobbles (88/131: 67%). They mostly weigh between less than 200 and 400 g, especially in the layers 3 and 4. Their average length is 94 mm, width 67 mm and thickness 38 mm **(Table 4.6.3.4, figures 4.6.3.5 & 4.6.3.6)**. Therefore, they are considerably smaller than the typical sumatraliths and are much closer to the scrapers as far as their dimensions are concerned. Further analysis should shed light on the relationship between these three tool types. It is clear that partial sumatraliths cannot be considered as unifinished typical sumatraliths, as right from the beginning they are smaller tools. The frontal view of the partial sumatraliths are often half-oval (48%), especially in the layer 6 (10/13) and the transversal view rather oval (37/131: 28%). Delineation of their edges in sagittal view is more incurvated and non-symmetrical.

Around 41% of these tools are "non-cortical dominant" on their upper face. They are shaped by more than 10 removals (51% of the cases) of which the maximal length averages 31-40 mm and removals are three-directional in pattern (nearly 45%; **Tables 4.6.3.13 & 4.6.3.15**). The lower face is mostly "totally cortical" (63%), or shaped by 2 or 3 removals measuring 10-20 mm for the longest of them.

For the lateral and distal edges, they are almost always unifacially shaped **(Tables 4.6.3.17 & 4.6.3.18)**. The edges are more "acute" (30°-60°) on the lateral and distal edges while the proximal edge is more open (80°-100°) and often formed by fracture **(Tables 4.6.3.20, 4.6.3.21 & 4.6.3.22)**.

6) Hammerstones

With a total of 745 items, the hammers represent about 7% of the assemblage in the whole sequence suggesting that they might have been actually used to knap stone artefacts. They are more significant is in the upper layers (3: 338= 9% and 4: 231=10%; **Table 4.2.2**). Most of them are made on gray sandstone (around 90%), with black sandstone, granite, quartz, quartzite, mudstone and siliceous shale as complementary raw materials. Their average dimensions are: length 89 mm, width 64 mm and thickness 43 mm **(Table 4.7.2, figures 4.7.6 & 4.7.7)**. Masses range between less than 200 and 2000 g with a maximal frequency below 200 g. Most of them are broken (63%), especially in the layer 9 (30/41: 73%). Two third of the fractures (67%) are perpendicular to the long axis of the original cobble and the other ones are inclined or parallel to the grand plane (split cobble); this is approximately similar in all the layers **(Table 4.7.6, figure 4.7.9)**.

The frontal view (contour) is mostly oval or half-oval, around 28-30%. Most of the hammers (around 70%) only show pounding marks (micro-cupules); on the other ones, these pounding marks are combined with chipping, especially in the lower two layers where this occurs in half of the cases (46-56%). Chipping alone is rare **(Table 4.7.8)**. The intensity of the marks is more medium (nearly 45%) rather than high or low **(Table 4.7.9)**. These use marks are equally located on all the sides and both faces of the hammers, perhaps slightly more frequent on the proximal butt (broadest; 23%) and less on the faces (12%; **Table 4.7.10**).

It is interesting to note that some of the hammerstones are reddened, probably due to heating by fire, and mainly found in the sector S20W10, with about 52 pieces (7%); their proportion increases from nil in the bottom layer 9 to 10% in the layer 3, where they are mostly found entirely burnt (71%). In the experimental production, some burnt hammerstones were used for tool manufacturing technique, just like wood or bone hammers, for final shaping of the large tools. They were found to be very efficient, probably because they had lower moisture content than natural stones. Therefore, they were possibly used for knapping in the final process of large and small tool manufacturing (the sumatralith group) (**Table 4.7.11**).

7) Big fragments

The large fragments are the second most common artefacts after the small fragments: around 319 specimens (3%) are present in the studied sectors. Their proportion does not vary much across the stratigraphy **(Table 4.2.2)**. It is to be noted that they are rarely found from sector S21W10. Their principal raw material is gray sandstone (nearly 80%) along with some black sandstone, quartz, mudstone, granite, siliceous shale and zeolite, except for quartzite which is preponderant in layer 4 (18/85: 21%). Their measurements are: length 126 mm, width 79 mm and thickness 50 mm **(Table 4.8.3, figures 4.8.4 & 4.8.5)**. Masses range between less than 200 and 1800 g and concentrate between 201 and 600 g. Most of them are fragments of cobbles mostly resulting from “perpendicular” fractures (75%) or “split” (20%) with a few “oblique” fractures **(Table 4.8.5, figure 4.8.7)**.

The general morphology is more often irregular in shape (nearly 35%). Many of these big fragments seem to have been utilized as they show damage on their edges, in the form pounding marks especially on the proximal side (31-50%; **Table 4.8.9**), or in the form chipping, which is more frequent in the layer 4 (45%; **Table 4.8.10**) than in the other layers (15-30%).

These artefacts therefore complement the tool kit of the more formal shaped implements. These big fragments also display reddening of their surface, either entirely (78%) or on the cortex only **(Table 4.8.11)**. However, burning is apparently absent in bottom layer 10 (in the studied sample; sector S20W10) but the large fragments display damage suggesting that they were utilized as tools. In other layers most of them were burned after being fractured and the other ones before. Some fractures are obviously of thermal origin (convex and parallel to the cortex) but many other ones may not be identified as thermal fractures. It is possible that the fragments, big and small, result from some specific activity related to fire. However, these burnt fragments may not be part of the stone tool repertoire. They may also relate to hot rock cooking or other heating activities or some other stone using activity.

8) Small fragments

The small fragments represent the major artefact category in all the layers, with 7222 (67%) specimens **(Tables 4.2.2 & 4.9.1)**. Their proportions grading between 56 to 83%, are the highest in layer 7, and least in layer 4. Their frequency does not show any pattern in relation to depth of the layers. Actually, they have different origins; many of them result from stone knapping as they can be identified as flake fragments. These vary in proportions between layers and are more significant in the layer 5 (80% of the small fragments) and are much less in the bottom layer 10 (10%). The other fragments are amorphous pieces of rock or could not be identified as flake fragments. Besides the common gray sandstone (around 80-90%), the black sandstone (nearly 10%) and other raw materials such as mudstone, quartz, quartzite, siliceous shale, granite and zeolite are rare (less than 5%) among flake fragments and small fragments. Many of breakage patterns not identified as thermal fractures in this common local sandstone material may be due to fire. Although area 2 did not yield any hearth features, it might have been littered with debris rejected from area 1 **(Tables 4.9.2 & 4.9.3)**.

9) Unmodified manuports (cobbles & pebbles)

A total of 276 (3%) unmodified manuports (cobbles & pebbles) are represented in the studied sectors **(Table 4.2.2)**. Their distribution is similar in all the layers, most of them are not proportionally representative with regard to the statistics. The main raw materials are the same as usual, mostly comprised of gray sandstone (around 86%). They are mainly cobbles (42%) or broken cobbles (nearly 40%). Their average dimensions are: 106 in length, 75 mm in width and 50 mm in thickness **(Table 4.10.3, figures 4.10.4 & 4.10.5)**. Masses are clustered around less than 200 g. These unmodified manuports (cobbles & pebbles) are broken in half of the cases; their fractures are more perpendicular (nearly 70%) to the long axis of the original cobble, with oblique or split fractures around 15% **(Table 4.10.6, figure 4.10.8)**. Their general morphology is broadly similar to that of the hammers, mostly oval, around 32%. They show some damage on the edges which may be due to utilization: actually it may not be right to consider them as not intentionally modified **(Table 4.10.8)**.

5.2) Experimental replication of stone artefacts using modern raw materials samples from Nam Lang River, Ban Tham Lod Village, Pang Mapha District, Mae Hong Son Province

The lithic assemblages and stone artefacts discovered from late Pleistocene in Thailand (and Southeast Asia) clearly demonstrate the existence of prehistoric people. Most of them consisted only of cobbled tools, one side of which comprised of deep hollows and the upper had flaked scars (Gorman 1970; Bronson and Charoenwongsa 1988; Pookajorn 1994; Anderson 1986). The stone assemblages discovered in north-western Thailand, are made on the river cobbles (Gorman 1970; Bronson and Charoenwongsa 1988; Santoni et al. 1990; Reynold 1992; Shoocongdej 2002, 2004, 2006, 2007; Marwick 2008). The prehistoric manufacturers might have used different crude techniques: an anvil or block-on-block, bi-polar techniques with hammerstones, free-hand percussion, step or controlled flaking techniques **(see in the appendix B: Table 3, figure 1)**. Besides these, the Clactonian method could have been possibly used as well.

However, a careful study of the stone tool techniques at the site of Tham Lod Rockshelter convinces us that the majority of makers used free-hand percussion with hard hammerstone primarily towards the end of tool manufacturing (Sankalia 1964; Inizan et al. 1999). However, sometimes, some other steps might have been followed such as: step controlled flaking and woods or bone hammer techniques.

To study mainly the typology and function of the stone assemblages and the manufacturing techniques of tools modern raw materials were used and replicated into experimental stone artefacts using different techniques and methods (Sankalia 1964; Inizan et al. 1999). The river cobbled from Nam Lang River, near the Tham Lod, were selected for the experimental production of the stone artefacts following the way it was made in late Pleistocene. The lithic artefacts have been knapped using different shapes of raw materials. Several types of cobble tools were made replicating the shape and size similar to those of the late Pleistocene tools found in Thailand (Marwick 2008). The actual tools - choppers, scrapers, typical and partial sumatraliths, denticulates and pointed tools - were made and utilized in differing activities to help infer function.

Various types of these tools have been found in the stratigraphic sequence at the site of Tham Lod and also discovered in several other parts in Thailand and Southeast Asia as well (Gorman 1970; Anderson 1986, 1990; Pookajorn 1994, 2001; Moser 2001; Shoocongdej 2002, 2007; Marwick 2008).

Though experiments were aimed at reconstruction of techniques and tools as used by late Pleistocene hominins, but sometimes, as it appears, they are rather smaller in size because the raw materials are in limited quantity and smaller in sizes than those existed during the prehistoric times (Marwick 2008, 2008a). Also, the stone raw materials had less compaction, but were high in moisture content (Shoocongdej 2002, 2004; Marwick 2008). From the experiments, free-hand percussion with hard hammer stood out compared to other techniques. They were mainly used on gray sandstones that are found in this region. Most of them were quite similar to those implemented during the late Pleistocene of Tham Lod Rockshelter.

Around 45-50 modern raw materials were selected from Nam Lang River, near Tham Lod Rockshelter for these experimental flakes and a total of 30 artefacts were replicated as experimental tools **(Table 5.2.1)**. Out of these, there are 6 end choppers, 5 side scrapers, 9 typical sumatraliths, 5 partial sumatraliths, 2 denticulates and 3 pointed tools. A total 260 flakes have been removed from the modern raw materials, and all of them have been analysed for these purposes which are summarised as follows:

No.	Type of artefacts	Number of toots experiments	Length (mm)	Width (mm)	Thickness (mm)	Weight (g.)
1	Flakes	260	33	31	9	-
2	End choppers	6	127	92	53	700-1200
3	Side scrapers	5	82	74	39	160-300
4	Typical sumatraliths	9	132	73	46	390-820
5	Partial sumatraliths	5	115	80	46	300-475
6	Denticulates	2	96	69	46	350-390
7	Pointed tools	3	91	82	46	200-250

Table 5.2.1 The total number of tools and flakes experiments from modern materials, represented in the average of length, width and thickness, along with weight (in gram).

Experimental tools	Distribution and Examination
Flakes	260 flakes were knapped and analyzed in the experimental dataset which were then made into different tools: end choppers, side scrapers, typical and partial sumatraliths, denticulates and pointed tools **(Table 5.2.1)**. The modern materials used are gray sandstones, and the average dimensions are: length 33 mm, width 31 mm and thickness 9 mm. The longest flake is 71 mm, widest is 78 mm. The shortest is 10 mm and narrowest one is 11 mm. It is to be noted that the averages length, width and thickness of experimental flakes are quite smaller than flakes in the archaeological assemblage from Tham Lod Rockshelter **(see in the appendix B: Tables 8 & 5.2.8)**. The experimental flakes have more diffuses (nearly 75%) than marked bulbs (57/260: 22%) on the ventral surface. The facetted platform marks very open angle “steep-inverse” with ventral face. The corticality of butt is rather conspicuous on the “non-cortical” (152/260: 58%) or “totally cortical” (nearly 35%), which have largely “plain” platform (58%), followed by linear (25%; 64/260). Punctiform, bifacetted and multifaceted platforms occur on less than 10% of the flakes. The dorsal face is mostly “non-cortical” (157/206: 60%), followed by the “non-cortical dominant” (54/260: 21%) and “cortical dominant” (32/260: 12%). Very few “totally cortical” are frequent (7%). The direction of scars is found to be more “unipolar” (177/260: 68%), indicating that most flakes have the same striking direction, followed by “bipolar-opposite”, around 13% (34/260). Some flakes are rarely “bidirectional-orthogonal” and “three- directions” as well as “convergent” pattern, which attest to more complex core reduction method (cores with several striking platform; **see in the appendix B: Tables 8 & 5.2.8**).

	The numbers of previous flakes are between 2 and 3 scars (58%: 151/260) on the dorsal face and 1 or 2 arrises, on nearly 65% flakes (166/260). For main shape of generally morphology are more preponderantly irregular (26%: 67/260) for the frontal view, noticeably triangular (35-48%) on the sagittal and transversal views. The angle edges are quite sharp (30°-60°) on the lateral and distal sides, with exception for the proximal side, presenting more open (>100°) at the striking platform. The actual tools from Tham Lod might be made employing free-hand percussion with hard hammerstones, producing a flake by striking another stone. The experimental flakes produced are quite related to blank flakes from Tham Lod, but they are frequently short, not elongated possibly due to quality of the raw materials from Nam Lang River, especially made from the modern sandstones **(see in the appendix B: Tables 8 & 5.2.8)**. Besides, the flakes from experiments are quite identical with typological striking, both of them have no conspicuous damage edges. They are not possible for the use-damage, presenting on these edges because there are no variations along any location on the flake edges of the cobbles. Therefore, the function of flakes from Tham Lod might be doubtful. It was possible that all the flakes had not used for any purposes during late Pleistocene because the lateral angles have not utilized edges. Otherwise, the flakes could possibly have been used for woodworking or butchering. Upon examination, the flakes from experimental tools are good for cutting the evergreen herbs, edible roots or for scraping meats or fishes because they are very sharp angles.
End choppers	A total 6 specimens of end choppers were experimentally struck from modern gray sandstones, and all of tools are unifacial shaped. The average measurements are: length 127 mm, with 92 mm and thickness 53 mm **(Table 5.2.1)**. Masses range between 700 and 1200 g, but are concentrated between 1000 and 1200 g. Most of them are made on broken cobbles (4/6: 67%) or whole cobbles (33%; **Tables 5.2.2 & 5.2.8**). The frontal view (contour) is mostly oval (3/6: 50%) or irregular (33%); the transversal view is more trapezoidal (4/6: 67%). The delineation of edges is quite constant between incurvated and straight as well as symmetrical and non-symmetrical in sagittal view. On the upper faces, the end choppers are more common, mostly “non-cortical dominant” or “cortical dominant”, about 50%. They are usually shaped by 3 or 4 removals, mostly “unipolar” direction. The length of the longest removal is between 31 and 40 mm, and the extent of the shaping is more “extensive” (4/6: 67%). On the lower face, they are mostly “totally cortical”, for 67%. The edges are rather open “steep” (80°-100°) on the lateral and proximal sides, medium to open (60°-80°) on the distal side. The nature of the edges is mostly “cortex”, with the exception of the distal position, remarkably “removal unifacial”. It is to be noted that the choppers are widespread in north-western Thailand from the beginning of the late Pleistocene, but at several Hoabinhian sites in Thailand, choppers are rare. Tham Lod is the new highlight of the Hoabinhian culture as many differing types of tools have been found here, mainly end and side choppers. The end choppers from Tham Lod might have been knapped by free-hand percussion with stone hammer technique because the typological implements are somewhat identified to experimental examples, but their sizes are quite smaller. Also, the masses are more heavy than actual tools from Tham Lod **(Tables 5.2.2 & 5.2.8)**. The end choppers from experimental replication were best used on hard materials (woodworking and butchering). Basically, the striking point frequently occurs along the cutting edge, and 3-4 flakes removed from

	the natural surface on the upper face. They had traces of wear on upper surface and on the cutting edges, with long striations. This kind of wear is possibly from friction of the hand showing that this tool was held in bare hands. The working movement is unidirectional from outside position towards the body of user. The traces of use undoubtedly show that end choppers might have been used not only for chipping out tree barks, but also scraping flesh from bones, fat, muscle and fibers of animal from the skin. Some end choppers probably were used for cutting bamboo trees, palm-trunk or rattan-caudex. It is to be note that the end choppers have been use in different propose activities such as cutting, scrapping or digging as similar as hatchet in the present **(figure 5.2.4)**.
Side scrapers	There are a total 5 side scrapers in the experimental sample, and all of them usually measure less than 10 cm. Their average measures are: length 82 mm, width 74 mm and thickness 39 mm. The main supports are broken cobbles (60%) or cobbles (2/5: 40%). Masses are extremely marked between 200 and 300 g and they are always unifacial in shape **(Tables 5.2.1)**. The frontal view is more distinctively triangular (60%); the transversal view is mostly trapezoidal (4/5: 80%; **Tables 5.2.3 & 5.2.8**). Around 80% of these tools are "cortical dominant" on the upper face. They are shaped by 5 or 6 removals (40%) of which the maximal length averages 21-30 mm. The extent of shaping is more "extensive" (3/5: 60%). The lower face is mostly "totally cortical" (3/5: 60%). The nature of the edge is markedly "removal unifacial" in left position. In other positions, it is mostly "cortex". The lateral edges are mostly sharp to medium angled (30°-60°) for the left edge and essentially medium to open (60°-80°) for the right edge. The distal and proximal edges, they are more open (80°-100°). In the experiments, the side scrapers are also made by the same striking technique as the choppers because the technological and typological forms are not different, except for the sizes and weights, where they are quite smaller than other tools. Only the side scrapers are retouched conspicuously on the lateral positions **(Tables 5.2.3 & 5.2.8)**. The experimental samples were best used for woodworking and butchering such as similar to use the knives for cutting or scraping at present. From this result, the traces of wear on the side scrapers show that the wear is due to usage, which occurs along the cutting edge, bearing several large striations occurring on the upper face upto a width around 40-50 mm at the cutting edge. These striations are on the lateral sides, mainly left side with the cutting edge. Such features indicate that the working movement of the hand was one movement from outside position towards the body of user. Around 50-60% of the cutting edges are worn on the upper face, showing that this cutting edge penetrated part of the hard materials. The rubbing traces occurred lightly due to friction with the hand at the butt. In this way, it is quite possible that the side scrapers were used for cutting or striking the hard materials like wood or bone without a handle. The characteristic wear feature on these tools indicate that the woods are not cut by splitting, but by imbedding the cutting edge in the body of the wood to split off a piece by blow. Besides, the side scrapers are used possibly for cutting up meats or plantations such as bamboo shoot, rattan-caudex, palm leaf and banana tree from side scraping **(figure 5.2.4)**.
Typical sumatraliths	A total of 9 items of typical sumatraliths were replicated, all of them are unifacially shaped. The average measures are: length 132 mm, width 73 and thickness 46 mm. Their masses are clustered between 400 and 600 g **(Table 5.2.1)**. The main supports are mostly whole cobbles (6/9: 67%) or broken cobbles (33%). Their outline (frontal view) is usually oval or ellipses shaped (nearly 90%), their transversal view is mostly oval (45%) or triangular (3/9: 33%; **Tables 5.2.4 & 5.2.8**). Delineation of their edges in sagittal view is more incurvated and non-symmetrical, for (6/9: 67%).

	The upper face is more "non-cortical dominant" (5/9: 56%) or "non-cortical" (4/9: 44%). The shaping of tools is often made by 10 and 20 removals, and is mostly "very-extensive" (5/9: 56%) or "total" (4/9: 44%). The longest removal length is between 35 and 40 mm and the maximal is 65 mm and shortest one is 25 mm. Besides, the nature of the edges is overwhelmingly "removal unifacial" for the lateral and distal positions and in proximal portion "fracture" or "removal unifacial" is noticeable. The edges are mostly "oblique" (60°- 80°) on the lateral, distal sides and more "steep" (80°-100°) on the proximal side **(Tables 5.2.4 & 5.2.8)**. In the case of the experimental sample, the typical sumatraliths are well knapped by free-hand percussion with stone hammer technique, but the sizes of tools are quite bigger than actual tools from Tham Lod **(see in the appendix B: Tables 3, 5.2.4 & 5.2.8)**. It is interesting to note that the weights are rather similar to each other in average masses. The experimental tools were best used with hard materials (woodworking and butchering). They show not only traces of wear on the working end, but there are striations on the upper face also. Considering the wear traces on the tools, the working end is worn along the convex edge, and they show large and short striations covering the upper face. In the typical sumatraliths from the archaeological site of Tham Lod, the wear traces show that they had been in use for a long time. These traces can be identified that they were used for cutting or digging, depending on the shapes and sizes. Several long striations indicate that the working edge deeply penetrated into the soil, while, the striations indicate that it was used with a strong force against hard materials (Woodworking). Possibly they were used to dig the soil around bamboo shoots. Otherwise, these tools might have been used for digging in search of the edible roots or cutting the bamboo trees, rattan-caudex and/ or palm trunk **(figure 5.2.4)**.
Partial sumatraliths	Only 5 artefacts of partial sumatraliths were experimentally struck and most of tools are not completely shaped on the upper face, but always unifacial shaped. Their average dimensions are: 115 mm in length, 80 mm in the width and 46 mm in thickness. Masses range between 400 and 500 g **(Table 5.2.1)**. The large majority of supports are broken cobbles (4/5: 80%) or whole cobbles (1/4: 20%). The general morphology is usually oval (40%) or triangular (40%) for the frontal and transversal views **(Tables 5.2.5 & 5.2.8)**. The upper face is often "non-cortical dominant" (80%) and usually shaped by more than 8 removals. The length of the longest removals is between 31 and 40 mm, and are mostly "three directions" or "convergent", for 40%. The extent of the shaping is markedly more "very extent" or "extent", about (2/5: 40%). When occurring on the lower (flattest) face, around 60% are mostly "totally cortical". The nature of the edges is noticeable "removal unifacial" in the lateral and distal positions and in proximal portion "fracture" is more conspicuous. The edges are more medium to open (60°- 80°) on the lateral and distal sides, but more open (60°-80°) on the proximal side **(Tables 5.2.5 & 5.2.8)**. Upon examination, half of the sumatraliths show that they should have been used in a similar function as an axe. The manufacturing technique was free-hand percussion with stone hammer. Essentially, it is quite clear that these types of traces could only be formed by blows in which both faces or cheeks of the working edge encounter uniform resistance from the hard materials, which could only arise if the working edge is at right angle to it. In any case, such traces indicated that the short axe should be used for cutting or breaking. The discoid unifacial revealed that the working edge round the circular edge of the tool show analogous traces. The wear marks appear at the projection of the edge as scars on the upper face, while there was a variable degree of blunting along the working edge. It is quite obvious that the discoid unifacial

	were not used only for cutting, but also for some kind of scraping. The tool's movement was unidirectional, moving from the opposite side towards the body of the worker. Therefore, the only possible use, which could have been responsible for such traces would be sealing of fishes or scraping of edible roots, mainly cassava roots or evergreen herb **(figure 5.2.4)**.
Pointed tools	Only 3 pointed tools were experimentally replicated; their main supports are whole cobbles and mostly unifacial (67%) or bifacial (1/3: 33%). Masses range between 200 and 250 g and the size are rather smaller than for the other core tools: length 91 mm, width 82 mm and thickness 46 mm. The frontal and transversal views are mostly oval shapes, in about 67% cases **(Tables 5.2.6 & 5.2.8).** On the upper face, these tools are mostly "cortical dominant" (67%) and they are usually shaped by 4 removals. The extent of shaping is mostly "marginal" (67%) or "very extensive" (1/3: 33%). The length of the longest removal is between 30 and 40 mm. When occurring on the lower face, the longest removal is between 20 mm. Regarding their nature, the edges have markedly unifacial removals on the distal position, while in the lateral and proximal positions, cortex is preponderant. Angle of the lateral and proximal sides are more medium to open (60°-80°) and quite sharp (30°-60°) on the distal side **(Tables 5.2.6 & 5.2.8).** Upon examination, the pointed tools show that the tip is polished which could have been by wear against the soft body of the animals. Only if it had transfixed the bodies of animals or the tip of tools could be broken by wear against the hard materials on which the pointed tool had made the groove. The pointed tools were often broken against animal bones. Also, they were grasped in the palm of the hand and then pressed forward and up, a point would have made an excellent knife for ripping open the carcass of animals. Otherwise they could have been used for digging the edible roots: cassava roots or bamboo shoots **(figure 5.2.4)**.
Denticulates	Only 2 specimens of denticulates are experimental. The supports are made on the broken cobbles or whole cobbles (50%). Masses of denticulate tools are identical with those of pointed tools, mostly between 350-400 g **(Table 5.2.1)**. Their average dimensions are: length 96 mm, width 69 mm and thickness 39 mm. The general morphology is triangular in frontal view and trapezoidal in transversal view **(Tables 5.2.7 & 5.2.8)**. The delineation of the edges is often sinuous and symmetrical in sagittal view. On the upper face, they are shaped by 7 or 8 removals and extent of the shaping is mostly "marginal". The length of the longest removal is between 25 and 30 mm. The formed naturals are more "cortex" or "fracture" with the exception of the right side, which is "unifacial removals". The edge is more sharp (30°-60°) in the right side and is more medium to open in the left side, while the distal and proximal sides, they are more open (80°-100°). The examination of the denticulates indicates the possibility that most of tools should have been used for scraping meats or fishes as well as cutting some rattan-caudex, palm trunk or leaf, evergreen herb or edible roots **(figure 5.2.4)**.

5.2.1 Reconstruction of lithic technology at Tham Lod Rockshelter

Overall, the experimental replication was designed towards the production of Hoabinhian artefacts as they were made during the Pleistocene period **(figures 5.2.1, 5.2.2 and 5.3.2)**. The result of experimental analysis has helped us understand the manufacturing techniques, typology and function of the tools from Tham Lod Rockshelter. The analysis shows that three techniques are mostly important such as an anvil or block-on-block technique, the bi-polar technique and the free-hand percussion technique which were applied for the primary flaking. The step or controlled flaking technique and cylinder hammer or wood - or bone hammer technique - were mainly used for the secondary working or preparing the end of cobble tools **(see in the appendix B: Table 3, figure 1)**.

Analysis of the whole assemblage from Tham Lod coupled with experimental replication of the characteristic stone artefacts has helped us understand the tool marking technique used at Tham Lod Rockshelter which can be summarized as below:

***Sumatraliths and Bifacial tools*:**

The sumatralith and bifacial tools discovered at Tham Lod were classified into different types: oval horse-hoof (unifacial), ellipsoidal or oval flat (unifacial or bifacial), large triangular pick and irregular unifacial etc. These stone artefacts might be made by the free-hand percussion for primary flaking, and by the step or controlled flaking technique for secondary flaking or final shaping of the tool. Using free-hand percussion technique, a long, large and shallow flake was removed along the edge of the cobble from its upper face. Then, some retouches were given all along the crude edge to form a fine sharp cutting edge. From these types, a long and large flake was removed from all over the upper face and the edge was retouched by free- hand percussion with a soft or small hammerstone. Considering the force of percussion, which was applied to a stone artefact, it should be noted that a strong blow was given to remove a large flake, but a mild blow was given to retouch the edge.

***Choppers*:**

On the basic of the shapes and raw material used, the chopper groups were also divided into different types, but only two main groups were evident at Tham Lod Rockshelter, namely end and side choppers. The end chopper (ellipsoidal or oval) was made by an anvil or a bi-polar technique. With these techniques, three or four large flakes were struck off from the cobble to form the straight cutting edge. For the end chopper (triangular), few large and crude flakes were removed by anvil technique, and the secondary flaking was done to remove the sharp ends of the ridges from the straight cutting edge. By using the free-hand percussion technique, a large number of end chopper (oval or flat) and fine shapes were produced. The experiment of the giant end chopper, using an anvil and the free-direction percussion technique was used for removing two or three long flakes along the edge of the flat elongated cobble.

Side scrapers:

In case of the various types of side scrapers, the sizes of these small tools were less than 10 cm. The scraper types were made by free-hand percussion to get the large flakes, which were struck off from the cobble to form the straight cutting edge. Normally, the secondary flaking was done to remove the sharp ends of the ridges from the straight cutting edge. By means of step or controlled flaking technique, a large number of flake scars of fine shapes was produced. Other types like double, multiple and horse-hoof scrapers were only made by free-hand percussion technique, which were used for removing two or three crude and shallow flakes, evidently struck off from the cobble.

Pointed tools:

In contrast, two main pointed types of stone artefacts were the massive and small pointed tools. According to the shape and flaking techniques, they were subdivided into the small triangular picks and the massive crude picks. With regard to the technique of tool making, a large number of big flakes were struck off from the working end of the upper face by the free-hand percussion, and then by step or controlled flaking. They were used with a small hammerstone for secondary working to convert the edge and converge it into a crude point at an end of the cobble as a triangular pointed tool. The massive crude pointed tool was a characteristic tool of the crude pick type, which was made on a large cobble. Anvil and free-hand percussion were used to remove few large flakes from a straight cutting edge.

Other small tools:

The types of tools such as denticulate and discoid unifacial have rarely been revealed from Tham Lod Rockshelter, except for the atypical small tools, remarkably in different stratigraphic sequences. The atypical small tools were rather small artefacts. A few crude flakes were removed by free-hand percussion, and were made by only primary flaking. Other types like denticulate and discoid unifacial tools were made by free-hand percussion, while secondary flaking- step or controlled flaking technique was done to remove the shape ends of the rides from the straight cutting edge.

However, after free-hand percussion, using a soft hammerstone - antler, bone or wood, the stone artefacts were delicately crumbled by impact on the margin edges to prepare for utilization. It was suitable for the shaping of bifacial or unifacial performs, and for the removal of moderately regular small flake fragments. It is the easiest way to remove large, thin flakes. It was useful in producing thin bifaces or lithic artefacts that have been worked on both sides. It probably appeared in earlier Holocene sites in Thailand (and Southeast Asia).

In addition, pressure flaking produced flakes using antler, bone and wood - few pieces were found at Tham Lod Rockshelter, but more at Moh khiew and Lang Rongrien Rockshelters in south-western Thailand. The pressure flakes are small and fragile, and are used to thin and shape lithic artefacts. In many prehistoric sites from Thailand (and Southeast Asia), the stone artefacts are produced by a combination of all three techniques, with hard hammer percussion followed by soft hammer percussion, and then finished by pressure flaking, but, some of these techniques are rare found at Tham Lod Rockshelter.

Type of artefacts	**Numbers**	**Raw materials**	**Supports**	**Weight (g)**	**Measurement**			**General morphology**		**Upper face**				**Lower face**				**Angle of the edges**		
End choppers					Length	Width	Thickness	Frontal view	Transversal view	Amount of cortex	Number of removals	Direction of removals	Longest removals	Amount of cortex	Number of removals	Direction of removals	Longest removals	Angle of right and left edges	Angle of distal edge	Angle of proximal edge
Archaeological assemblage	102	G-sd (96%) B-sd (4%)	Bc (51%) Cf (28%)	401-600 (19%) 201-400 (17%)	133	89	56	Irre- (27%) Oval (27%)	Oval (28%) Irre- (27%)	Co (26%) Nco-d (25%)	3 (19%) 2 (18%)	Uni- (71%) Bi-opp (15%)	31-40 (24%) 41-50 (20%)	Co (56%) Co-d (27%)	1 (5/15) 2 (5/15)	Uni- (12/15) Bi-opp (3/15)	21-30 (7/15) 11-20 (5/15)	S (L) (34%) O (R) (28%)	A (38%) O (37%)	S (35%) Si (27%)
Experimental replications	6	G-sd	Bc (67%) Wc (33%)	1000-1200 (67%)	127	92	53	Oval (50%) Irre- (33%)	Trp (67%) Oval (33%)	Co-d (50%) Nco-d (50%)	3 (50%) 4 (33%)	Uni- (50%) Bi-ort (33%)	31-40 (50%) 21-30 (33%)	Co (67%) Co-d (33%)				S (L) (83%) S (R) (67%)	O (67%) A (33%)	S (67%) O (17%)

Table 5.2.2 Comparison of end chopper technological characteristics from archaeological assemblage at Tham Lod and experimental replications

Type of artefacts	**Numbers**	**Raw materials**	**Supports**	**Weight (g)**	**Measurement**			**General morphology**		**Upper face**				**Lower face**				**Angle of the edges**		
Side scrapers					Length	Width	Thickness	Frontal view	Transversal view	Amount of cortex	Number of removals	Direction of removals	Longest removals	Amount of cortex	Number of removals	Direction of removals	Longest removals	Angle of right and left edges	Angle of distal edge	Angle of proximal edge
Archaeological materials	33	G-sd (97%)	Cf (36%) Bc (33%)	101-200 (30%) 201-300 (24%)	133	89	56	Irre- (30%) Trp (27%)	Irre- (24%) Trg (21%)	Co-d (46%) Nco-d (30%)	5 (21%) 2 (21%)	Uni- (76%) Bi-opp (18%)	21-30 (30%) 11-20 (24%)	Co (55%) Co-d (15%)	1 (2/5)	Uni- (3/5)	11-20 (2/5)	A (34%)	A (37%) O (27%)	S (46%) O (27%)
Experimental replications	5	G-sd	Bc (60%) Wc (40%)	200-300 (80%)	82	74	39	Trg (60%) Irre- (20%)	Trp (80%) Ptg (20%)	Co-d (80%) Nco-d (20%)	5 (40%) 6 (40%)	Uni-	21-30 (80%) 31-40 (20%)	Co (60%) Co-d (40%)				O (L) (60%) A (R) (60%)	O (67%) A (33%)	S (67%) Si (40%)

Table 5.2.3 Comparison of side chopper technological characteristics from archaeological assemblage at Tham Lod and experimental replications

Type of artefacts	**Numbers**	**Raw materials**	**Supports**	**Weight (g)**	**Measurement**			**General morphology**		**Upper face**				**Lower face**				**Angle of the edges**		
Typical sumatraliths					Length	Width	Thickness	Frontal view	Transversal view	Amount of cortex	Number of removals	Direction of removals	Longest removals	Amount of cortex	Number of removals	Direction of removals	Longest removals	Angle of right and left edges	Angle of distal edge	Angle of proximal edge
Archaeological materials	117	G-sd (94%)	Wc (55%)	401-600 (32%) 201-400 (29%)	112	74	41	Oval (63%) Irre- (17%)	Trp (29%) Oval (16%)	Co (76%) Co-d (23%)	>10 (76%) 10 (9%)	Conv- (76%)	31-40 (35%) 41-50 (26%)	Co (65%) Co-d (23%)	1 (4/6)	Uni-	11-20 (3/6)	A (37%)	A (58%) O (29%)	A (35%) O (33%)
Experimental replications	9	G-sd	Wc (67%) Bc (33%)	400-600 (89%)	132	73	46	Oval (90%)	Oval (45%) Trg (33%)	Nco-d (56%) Nco (44%)	>10	Conv-	31-40 (56%) 41-50 (22%)	Co				O (33%) A (22%)	O (56%) A (33%)	S (67%) O (22%)

Table 5.2.4 Comparison of typical sumatraliths technological characteristics from archaeological assemblage at Tham Lod and experimental replications

Type of artefacts	**Numbers**	**Raw materials**	**Supports**	**Weight (g)**	**Measurement**			**General morphology**		**Upper face**				**Lower face**				**Angle of the edges**		
Partial sumatraliths					Length	Width	Thickness	Frontal view	Transversal view	Amount of cortex	Number of removals	Direction of removals	Longest removals	Amount of cortex	Number of removals	Direction of removals	Longest removals	Angle of right and left edges	Angle of distal edge	Angle of proximal edge
Archaeological materials	131	G-sd (96%)	Bc (67%)	201-400 (35%) <200 (34%)	76	83	38	H-oval (48%) Oval (16%)	Oval (28%) Trg (22%)	Nco-d (41%) Nco (23%)	>10 (51%)	Three- (44%) Conv- (26%)	31-40 (32%) 21-30 (28%)	Co (63%) Co-d (25%)	2 (21%) 3 (21%)	Uni- (11/19)	10-20 (6/19)	A (R) (44%) A (L) 43%	A (61%) O (26%)	A (44%) O (30%)
Experimental replications	5	G-sd	Bc (80%) Wc (20%)	400-500 (80%)	115	80	46	Oval (40%) Trg (40%)	Oval (40%) Trg (40%)	Nco-d (80%)	>8	Conv- (40%) Three- (40%)	31-40 (80%)	Co (60%) Co-d (40%)				O (R) (60%) S (L) (40%)	O (60%) A (40%)	S (60%) O (40%)

Table 5.2.5 Comparison of partial sumatraliths technological characteristics from archaeological assemblage at Tham Lod and experimental replications

Type of artefacts	**Numbers**	**Raw materials**	**Supports**	**Weight (g)**	**Measurement**			**General morphology**		**Upper face**				**Lower face**				**Angle of the edges**		
Pointed tools					Length	Width	Thickness	Frontal view	Transversal view	Amount of cortex	Number of removals	Direction of removals	Longest removals	Amount of cortex	Number of removals	Direction of removals	Longest removals	Angle of right and left edges	Angle of distal edge	Angle of proximal edge
Archaeological materials	23	G-sd (78%)	Bc (35%) Cf (26%)	101-200 (48%)	81	52	31	Trp (31%) Irre- (26%)	Trp (39%) Trg (22%)	Co-d (52%) Nco-d (35%)	2 (31%) 1 (26%)	Uni- (74%)	21-30 (43%) 10-20 (26%)	Co (26%) Co-d (22%)		Uni- (2/2)	20-30 (2/2)	S (L) (52%) S (R) (48%)	A (74%) O (26%)	O (39%) S (35%)
Experimental replications	3	G-sd	Wc	200-250	91	82	46	Oval (2/3) Trg (1/3)	Oval (2/3) Trg (1/3)	Co-d (2/3)	4	Uni- (2/3)	31-40	Nco (2/3)				O (2/3)	A (2/3)	O (2/3)

Table 5.2.6 Comparison of pointed tools technological characteristics from archaeological assemblage at Tham Lod and experimental replications

Type of artefacts	**Numbers**	**Raw materials**	**Supports**	**Weight (g)**	**Measurement**			**General morphology**		**Upper face**				**Lower face**				**Angle of the edges**		
Denticulates					Length	Width	Thickness	Frontal view	Transversal view	Amount of cortex	Number of removals	Direction of removals	Longest removals	Amount of cortex	Number of removals	Direction of removals	Longest removals	Angle of right and left edges	Angle of distal edge	Angle of proximal edge
Archaeological materials	34	G-sd	Bc (41%) F (23%)	<100 (47%) 101-200 (26%)	77	54	30	Irre- (35%) Trp (21%)	Trg (38%) Trp (29%)	Co-d (47%) Nco-d (29%)	4 (24%) 2 (18%)	Uni- (70%)	11-20 (59%)	Co (47%) Nco (38%)	4 (3/5)	Uni- (2/5) Bi-ort (2/5)	10-20 (3/5)	A (R) (38%) O (L) (38%)	A (41%) S (26%)	O (38%) S (26%)
Experimental replications	2	G-sd	Bc (1/2)	350-400	96	69	39	Trp	Trg	Co-d (1/2)	7 (1/2) 8 (1/2)	Uni- (1/2)	21-30	Co				A (R) O (L)	S	S

Table 5.2.7 Comparison of denticulates technological characteristics from archaeological assemblage at Tham Lod and experimental replications

Table 5.2.8 Codification of lithic analysis at Tham Lod Rockshelter

Raw materials	G-sd: Gray sandstone B-sd: Black sandstone
Supports	Bc: Broken cobble Wc: Whole cobble Cf: Cobble fragment F: flake
Frontal &Transversal view	Irre-: Irregular Trp: Trapezoidal Trg: Triangular Rg: Right triangular Oval: Oval Ptg: Pentagonal H-oval: Half oval
Upper & Lower faces	M: Marked D: Diffuse Pla: Platform Lin: Linear
	Co: Totally cortical Nco: Non cortical Co-d: Cortical dominant Nco-d: Non-cortical dominant Uni-: Unipolar Bi-opp: Bipolar-opposite Bi-ort: Bidirectional-orthogonal Three-: Three-directions Conv-: Convergent Und-: Undetermined
Angle of the edges	(R): Right side (L): Left side VA: Very-acute A: Acute O: Oblique S: Steep Si: Steep-inverse

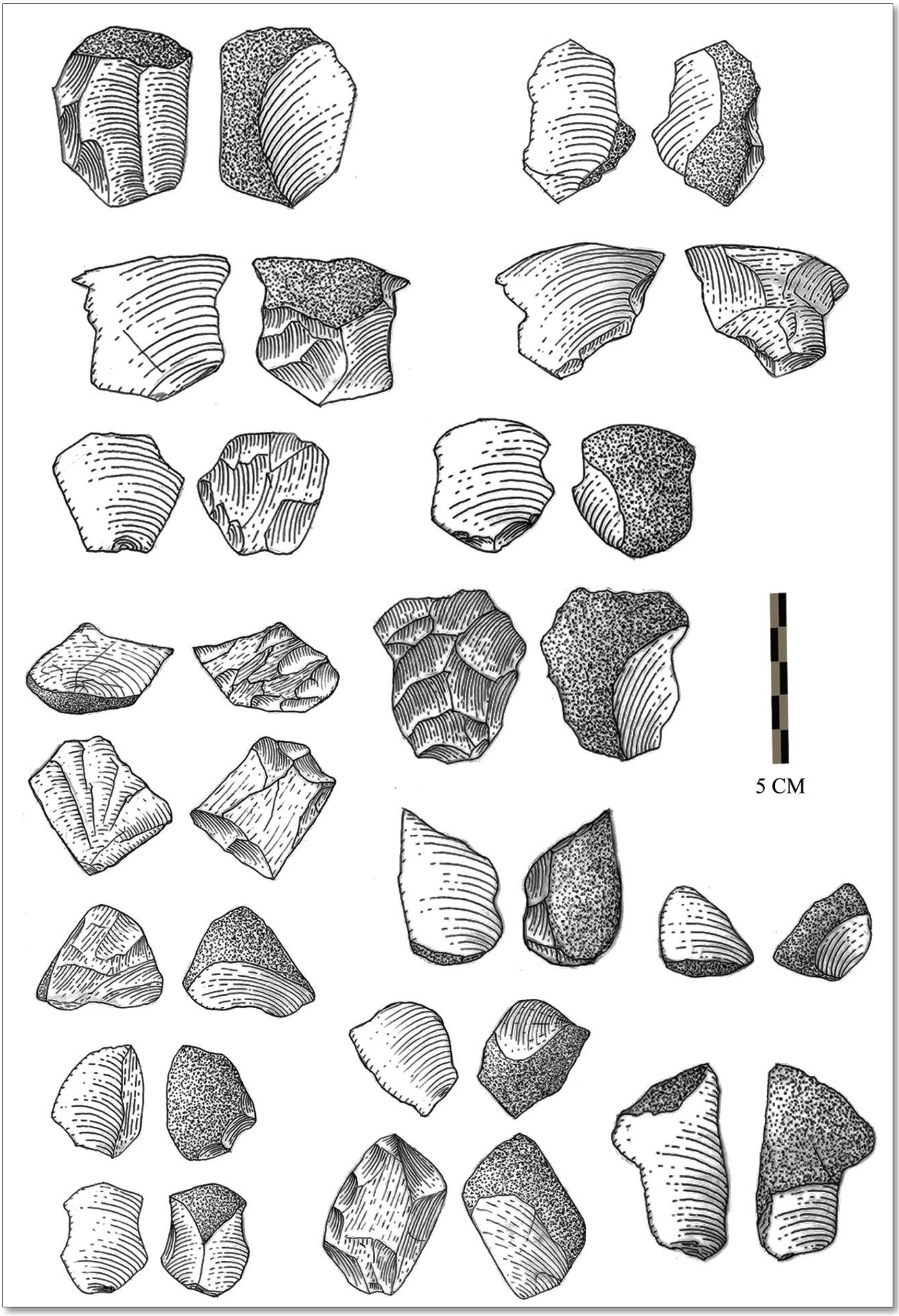


Figure 5.2.1 Flake artefacts from the experimental replications at Nam Lang River, Ban Tham Lod Valley, near Tham Lod Rockshelter (drawings T. Chitkament)

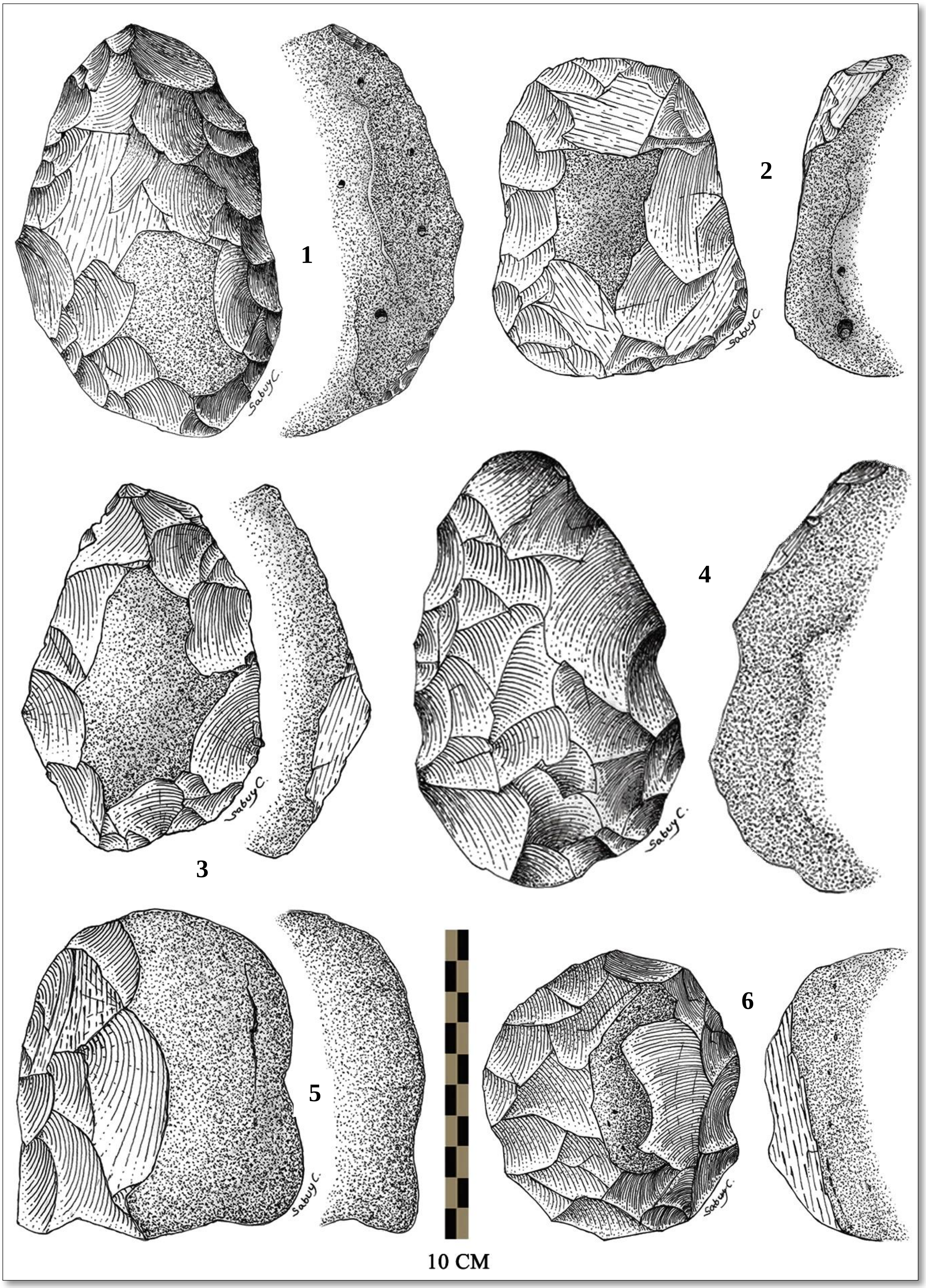


Figure 5.2.2 Stone artefacts from the experimental replications at Nam Lang River, Ban Tham Lod Valley, near Tham Lod Rockshelter (drawings T. Chitkament). 1 and 4) large typical sumatraliths, 2, 3 and 6) small typical sumatraliths, 5) partial sumatralith

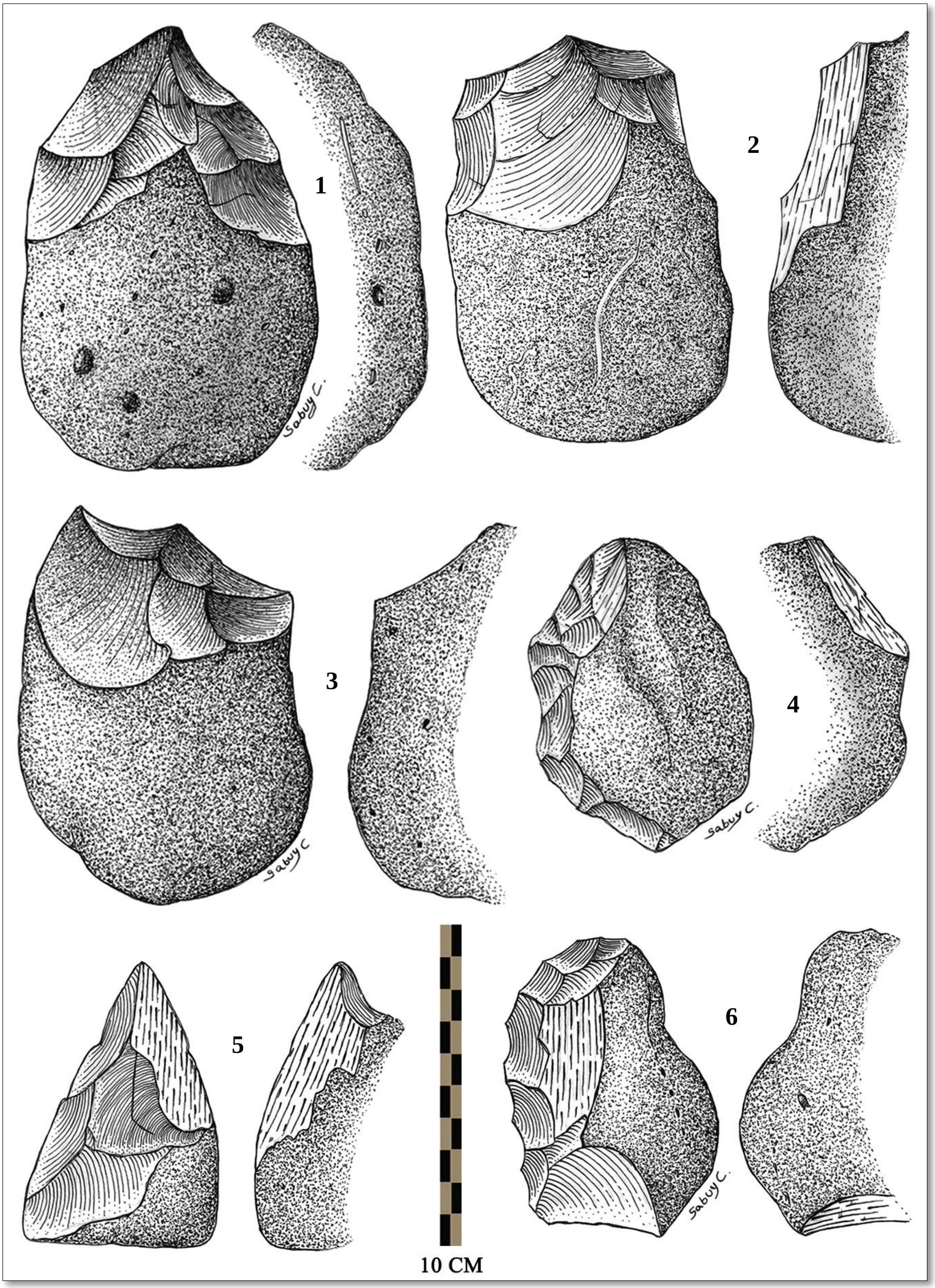


Figure 5.2.3 Stone artefacts from the experimental replications at Nam Lang River, Ban Tham Lod Valley, near Tham Lod Rockshelter (drawings T. Chitkament). 1, 2 and 3) end choppers, 4) side scraper, 5) pointed tool, 6) denticulate

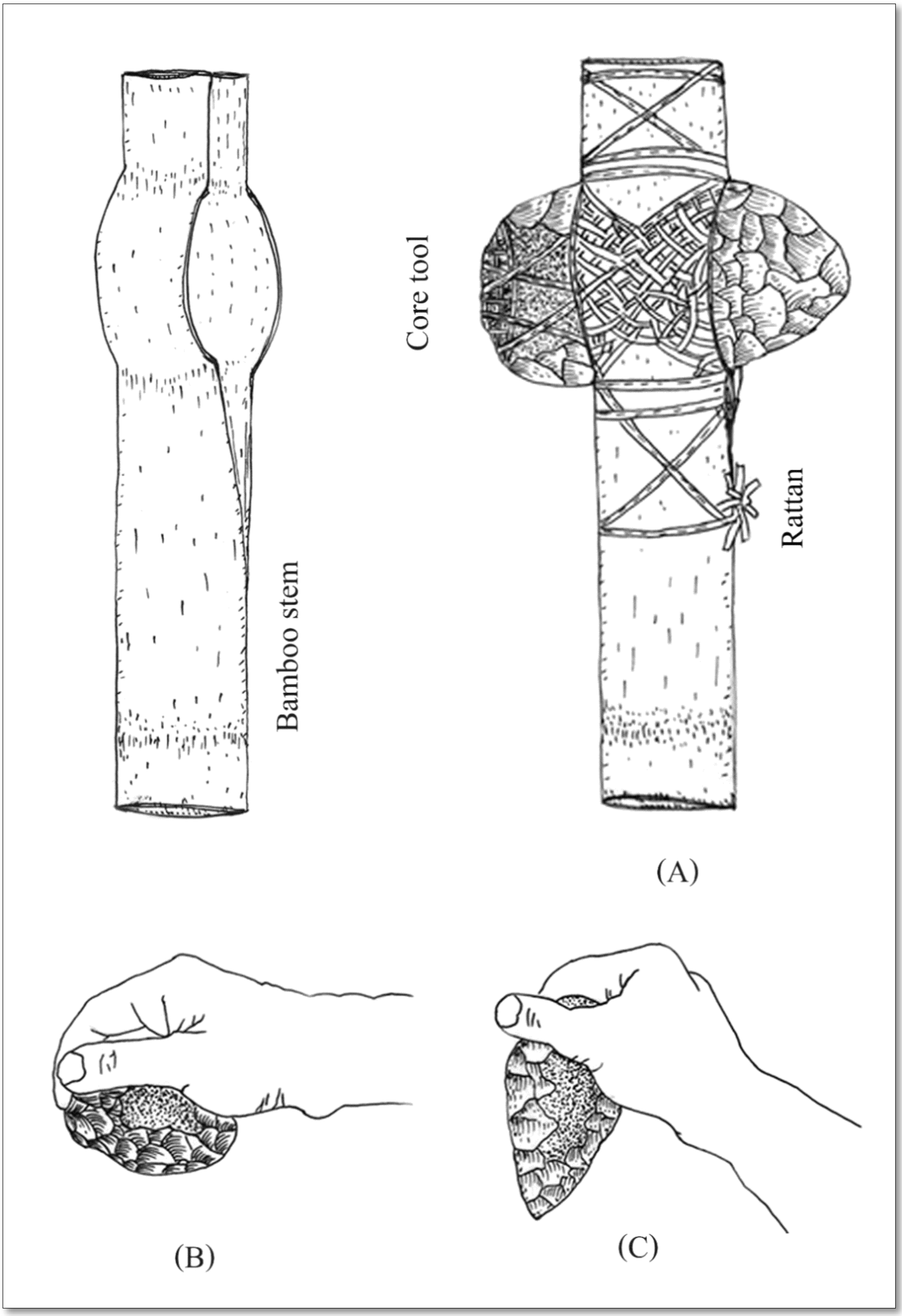


Figure 5.2.4 Drawings showing by experimental replications how the core tools could have been used, either hafted on to a bamboo stem (a: typical sumatralith) or held in the hand (partial sumatralith) for scraping on the lateral edges (b) or digging with the distal edge (c)

5.3 The significance of cultural behaviour during late Pleistocene and early Holocene in northwestern Thailand

The synthesis about the lithic assemblage from area 2 of Tham Lod Rockshelter is presented in chapter V. The artefacts have been analysed in each of the layers, from layer 10 at the bottom to layer 3 at the top of the Pleistocene sequence (chapter IV). In the top layer 2, which is Holocene, some artefacts have been combined with the recent items from layer 1. Hence, to avoid problem of identification of these mixed archeological remains, this layer was not included in the study, which only considered the late Pleistocene layers. The lithic assemblages will be discussed in general within their context, based on the information which is available in the excavation reports (Shoocongdej 2003, 2004, 2005, 2006, 2007). Many radiocarbon - AMS and TL dates from the three excavated areas of Tham Lod Rockshelter have helped in building the chronological sequence and in identifying the different occupational stages (Shoocongdej 2003, 2004, 2005, 2006, 2007, Khaewkamput 2003 and Khaokhiew 2003, 2004). Analysis of the lithic assemblages lead to group the layers 10 to 3 (late Pleistocene) into 3 main units: lower layers 8 to 10, with the layer 10 slightly apart, middle layers 5 to 7 and upper layers 3 and 4. These three units correspond to three slightly different cultural stages. They are presented with the numbering of layers as it is in the excavation area 2, which is different from the numbering in areas 1 and 3.

Late Pleistocene period

Lower unit: layers 10 to 8

In the bottom layer 10, the chronological sequence corresponds to that of the layers 8a and 8 of area 1, along with the layer 4 of area 3, the ages of which have been estimated around 35-33 ka BP. This date is the earliest in north-western Thailand **(Table 2.5.9)**. In these bottom layers, mainly in the bottom layer 10, the bedrock was not reached. Archaeological materials are rare, especially animal remains. The lithic artefacts were mostly small fragments (more than 75%) in area 2. The other artefacts are hardly represented. Although the material is not abundant (and therefore may not be statistically representative) it seems that the raw materials are more diversified. For the blank flakes, the length and width are quite bigger (longer or wider) than in the other layers and they have more scars on the dorsal face, suggesting a proper core reduction sequence intended to produce flakes, although no core was found in this layer. All the 4 scrapers are made on flakes or fragments while in the overlying layers scrapers are mostly made on broken cobbles. The majority of actual tools (large and small) are choppers (60% = 11 specimens) and no sumatraliths were discovered in the bottom layer 10. Therefore, this layer may not yet be Hoabinhian and may represent a transition between a flake and core technical tradition and a core-tool technical tradition.

Then, in layer 9, corresponding to layers 7 and 6 of area 1, besides layer 3a (lower part) of area 3, the chronology is estimated to between 32 and 25 ka BP (Khaokhiew 2004; Wattanapituksakul 2006 Shoocongdej et al. 2007; **figures 2.4.2 & 2.4.3**). The archaeological remains are represented by lithic artefacts and faunal remains. In area 2, the stone artefacts from sectors S20W10 and S21W10 increased in number from the former layer (layer 10), especially unretouched flakes and fragments, which are rather notable in this layer. The actual tools reach approximately 10% of the artefact assemblage. Out of these, there are choppers (nearly 40% of the tools: 29/75), scrapers and sumatraliths, rather identical in abundance (around 25% each). There are sumatraliths (typical sumatralith: 11%=8 and partial sumatraliths 13%=10), along with 2 cores **(Table 5.3.5a)**.

According to Wattanapituksakul (2006), only a few mammalian taxa were unearthed from layer 7 of area 1, such as deer (Cervidae), ruminants (Ungulates), and Eurasian wild pig (*Sus scrofa*). These mammals might have been transferred from former layers, and proficiently appeared in these layers. The mixed deciduous forest (*Tectona grandis*, *Lannea* sp. in family Anacardiaceae) is also known for its wide range of environments, being able to settle in various habitats **(see in the appendix B: Table 4)**.

Next in area 1 (layer 6), the diversity of mammals increased as proved by the mammalian teeth, which are determined to around 6 taxa: rodents (Rodentia), bamboo rats (Rhizomyidae), Eurasian wild pig (*Sus scrofa*), deer, wild cattle (Bovinae) and serow and goral (*Naemorthedus* sp.). It is important to note that most of the mammalian taxa are identical to those of layer 9 in area 2, including bears (Ursidae) **(see in the appendix B: Tables 4 & 5)**.

These mammals gradually doubled in number from the lower layers, and most of them inhabited in different forests environments such as limestone forest: Xerophyte (*Dracera loureiri* and *Eupobia* sp.), hill evergreen forest: (*Pinus merkusii*, *Pinus kesiya*, *Quercus* sp. and *Castanosis* sp.), and bamboo forest: (*Bambusa arudinacea*, *Bambusa nutas*, *Cephalostachyum pergracile*, *Cephalostachyum virtum*, *Dendrocalamus giganteus*, and *Dendrocalamus hamiltonii*: **see in the appendix B: Table 7)**. All these forest taxa were common in this layer (Lekagul & McNeely 1988; WWF Thailand programme office 2000; Parr 2003; Wattanapituksakul 2006).

The upper layer of lower unit (layer 8) corresponds to layer 5 of area 1 and to layer 3b of area 3. In these layers, the ages are also estimated to between 32 and 22 ka BP. Actually, there are many dates obtained from the layer 5 of area 1 and they wary within a large range of results (Khaokhiew 2004; Wattanapituksakul 2006; Shoocongdej 2006, 2007; **figures 2.4.2 & 2.4.3**). The lithic artefacts from area 2 sectors S20W10 and S21W10 increased compared to the lower layers 9 and 10. The fragments remain extremely frequent, mainly the small fragments (70%) but other stone artefacts types are generally more abundant than in the lower levels, just like the real tools, among which choppers are the most numerous. The scrapers and sumatraliths are somewhat equal to the previous layer 9, but the atypical small tools are abundant as well as hammerstones.

Besides, in area 1, the mammalian taxa sharply increased in layer 5; around 29 taxa were identified **(see in the appendix B: Table 4)**, but about 6 taxa are related to the previous layer (in the lower levels, layer 6): bamboo rat (*Rhizomys* sp.), bay bamboo rat (*Cannomys badius*), rodents in genus *Bandicota*, as well as bandicoot rat (*Bandicota* sp.) and greater bandicoot rat (*Bandicota indica*), Asiatc black bears (*Ursus thibetanus*), water buffalo (*Bubalus* sp.; Wattanapituksakul 2006). In area 2, only 8 mammals were identified from layer 8 and all of them belong to same taxa as in area 1 **(see in the appendix B: Table 5)**. Two species like Old world porcupines (Hystricidae) and bamboo rats increased from previous layer 9 (Amphansri 2004, 2005, 2011).

Most of the mammals identified in this layer, occur in forests like the mixed deciduous, hill evergreen, bamboo, and limestone forests with open forest or in grass fields near swamps (Lekagul & McNeely 1988; WWF Thailand programme office 2000; Parr 2003; Wattanapituksakul 2006). However, they are found in places according to the availability of foods and suitable habitats. All these environments were probably visited by the hunters-gatherers staying at Tham Lod Rockshelter and getting their game from the surrounding areas (Shoocongdej 2003, 2004, 2006, 2007; Wattanapituksakul 2006; Marwick 2008).

Therefore, in this lower unit, during a period dated to between 35 and 22 ka BP, the hypothesis could be made that the prehistoric people might have become knowledgeable of this region and began to settle the upland region during short periods. This time period corresponds to rather instable climatic conditions at the end of the isotopic stage 3 and before the last glacial maximum (Marwick & Gagan 2011). Firstly (layer 10), there were few hunter-gatherers occupying this region because they had to adapt themselves to the climatic and environmental conditions possibly too densely forested for them. Then, the population increased in the upper levels (layer 8) as could be observed from the archaeological remains. Therefore, this could validate the idea that the prehistoric population increased, and was composed of efficient hunters-gatherers, witnessed by the abundant faunal assemblage (more than 148,000 remains) discovered in the layer 5 of area 1.

Middle unit: layers 7 to 5

The middle layers of the sequence in area 2 of Tham Lod Rockshelter are only recovered in sector S21W10; in area 1, against the shelter wall, the layer 4 is correlated to them (Khaokhiew 2004; Wattanapituksakul 2006), but away from the shelter wall, they do not exist. They have been identified as a rock fall (collapse of the shelter wall) and they only occur closer to the cliff. Generally, the archeological remains were considerably reduced in these layers with the exception of faunal remains. Actually, less extent was concerned (only one sector in the studied area 2) and if it was a rock fall, a thick mass of sediment might have accumulated during a short period of time and thus the density of artefacts might be lower than in the other layers. The age of this unit is assessed from one date worked out from the layer 4 of area 1 and providing an age of about 25 ka. Anyway, given the dates of the above layers, this unit is assessed to have an age between 25 and 13 ka BP (Shoocongdej 2007). It might include the Last Glacial Maximum, around 20 ka BP, known as less marked in Southeast Asia than in northwestern Europe, and/or the cold Heinrich 1 event around 15 ka BP, quite severe in Southeast Asia and characterized by weaker monsoon and drier climate (Rashid et al. 2007; Marwick & Gagan 2011). It is possible that the rock fall making up these three layers (7 to 5) be linked to one of these cold events, or it may be due to some earthquake.

Most of the stone artefacts from area 2 sector S21W10 declined in layer 7 to the benefit of the small fragments, which represent 83% of the assemblage. All the tools (large and small: 5%= 66) are proportionally less than in the lower layers, especially choppers, scrapers and typical sumatraliths. Two cores were found in this layer **(Table 5.3.5c)**.

Next, the layer 6 is extremely poor in lithic artefacts and the assemblage includes very few flakes (9=4%). The proper tools and especially the typical and partial sumatraliths are proportionally more (25% each among the tools), similarly to choppers and scrapers

In the upper layer of the middle unit (layer 5), the lithic assemblage increased compared to layer 6, especially blank flakes (151/689=22%). By contrast, the actual tools (large and small) are less than in any other layer, in number and in proportion (except in layer 10) and some artefacts are rarely represented.

Around 18 mammalian taxa were identified in layer 4 of area 1 **(see in appendix B: Table 4)**; all of them decreased in abundance but showed the same diversity as in the former layer 5 (area 1). Similarly, in area 2, most of the mammals in layers 7, 6 and 5 are identical to the lower layers (8 to 9) and are the same species as in area 1 **(see in the appendix B: Table 5).**

The rhinoceroses (Rhinocerotidae) appeared in this layer of area 1 (Wattanapituksakul 2006) but were already found in layer 8 of area 2 (corresponding to layer 5 of area 1; Amphransri 2004, 2005, 2011). They indicate the occurrence of a dense forest during this period.

Palynological remains, found in layer 4 of area 1 show plant species such as *Pinus* sp., *Calocedrus* sp., Cyperaceae, Poaceae, Polypodiaceae, Pteridaceae, *Cyathea* sp., and *Ophioglossum* sp. (Treekanchanawattana & Pumijumnong 2005; Pumijumnong 2007). Most of these species are associated with various forest types: mixed deciduous forest, hill evergreen forest, bamboo forest, limestone forest, open forest/ grass field, dense forest and low-lying forest, but also to swamp (Lekagul & McNeely 1988; WWF Thailand programme office 2000; Parr 2003; Wattanapituksakul 2006).

During this probably short time period (rock fall) the prehistoric people could have settled down at Tham Lod while climate was somewhat dryer but landscape was still quite forested with various types of tree assemblages, and also with swamps. Food resources might have changed and people had to adapt to diverse types of forests. Analysis of the size of mammals is another important aspect (Brown and Wilson 1956, Davis 1981, Wattanapituksakul 2006; Marwick 2008: 164; more details in the discussion and conclusion).

Therefore, prehistoric people were regular hunters-gatherers and had adapted their technology to their environment as demonstrated by the increase in specialized large and small tools, especially sumatraliths. These sumatraliths are considered as tools especially adapted for working wood and bamboo in order to make finer tools than the stone tools (Boriskovsky 1967; Gorman 1970, 1971; Heekeren 1972; Testart 1977; Forestier 2010; Xhauflair 2014, 2015).

Upper unit: layers 4 and 3

The upper part of the Pleistocene sequence of Tham Lod Rockshelter is quite interesting because the Hoabinhian cultural assemblages are well represented. This upper unit includes the layers 4 and 3 of area 2, which correspond to layer 3 of area 1 and to layers 3 and 3a of area 3. Its age of is estimated to be between 24 and 12 ka BP, which is actually the same time range as the rock fall of the previous unit. The wide range of dating results does not allow more accuracy in the age estimates. Therefore, this unit might also have undergone the colder phases of global climate, rather dryer in subtropical zones: the Last Glacial Maximum (around 20 ka BP) and/or the Heinrich event 1 (around 15 ka BP). Very abundant archeological remains - stone artefacts, shellfishes, faunal and floral remains - were discovered in these layers.

In layer 4, the lithic artefacts sharply increased in comparison with the former layer (layer 5 of area 2). Small fragments represent a little more than half of the assemblage and this is the least proportion in the entire sequence. Then flakes, hammer stones and small tools are predominant. Among the proper tools (large and small) scrapers are quite frequent (56=28% of the tools) as well as typical sumatraliths (41=20% of the tools). The latter tool type is found in the highest proportion (with layer 6) in the stratigraphic sequence. Partial sumatraliths are less (34=17%) but they are better shaped (maximal number of removals in the stratigraphic sequence) and usually have their lower face totally cortical like the typical sumatraliths. Choppers are not frequent compared to the next layer 3 and side choppers are in the same quantity as end choppers, while in all the other layers end choppers are largely dominant.

Then, in the upper layer 3, the amount of artefacts still increased but fragments represent about 80% of the assemblage. Flakes, declined in value and in proportion. Among the tools, scrapers are not so important (53=20% of the tools). Typical sumatraliths (37=14%) are proportionally less than in layer 4 but partial sumatraliths (57=21%) are more. Choppers, especially end choppers are well represented, much more than in the previous layer 4. Thus the layer 3 seems to be less typically Hoabinhian than the layer 4, at least the typical sumatraliths decrease to the profit of the end choppers and the partial sumatraliths (which are slightly smaller and therefore cannot be considered as unfinished typical sumatraliths). Does this change correspond to an environmental change, as for instance the Bolling-Allerod warm period dating to approximately 14.5 to 12.5 ka BP?

It is interesting to note that three cores were recovered from layers 4 and 3 **(Tables 4.2.1 and 5.3.5d)**. Therefore there may be some production of flakes.

In these layers 4 and 3, the lithic assemblage appears more typically Hoabinhian than in the other layers. It is comparable but not similar to the early Hoabinhian of the lower levels and can be considered as stemming from it.

The mammalian remains slightly increased in these layers - around 20 taxa were discovered in layer 3 of area 1 **(see in the appendix B: Table 4)**. Some of them are Rhizomyidae, *Ursus tibetanus*, Rhinocerotidae and *Naemorhedus* sp. which lived in the forests similar to those of the former layers and in the layers 4 to 3 of area 2 **(see in the appendix B: Tables 4 & 5**; Amphansri 2004, 2005, 2011; Wattanapituksakul 2006).

The shellfish have also been identified during the late Pleistocene. The gastropods - snorket snail (*Rhiostoma* sp.), semi slug (*Meguastenia* sp.) and operculated landsnail (*Cyclophorus* sp.) - are discovered in these layers, mainly in layer 3 of area 1. The pearl mussel (*Margaritanopsis laosensis*) was identified in abundance at Tham Lod Rockshelter, and may suggest an environment similar to limestone forest, near the Nam Lang River (Wattanapituksakul 2006; Krajaejun 2007; Marwick & Gagan 2011).

According to Treekanchanawattana, Pumijumnong (2005) and Pumijumnong (2007), the palynological remains represented in layer 3 of area 1 are: *Pinus* sp., *Calocedrus* sp., Cyperaceae, Poaceae, Polypodiaceae, Pteridaceae, *Cyathea* sp., and *Ophioglossum* sp. Most of these species indicate different types of forests: mixed deciduous, hill evergreen, bamboo, and limestone forests **(Table 5.3.4d)**. However, these types of forests have been identified using recent forest data (The Remote Sensing and Geo-informatics System Center 1998, Lao Yi Pa 2000, Wattanapituksakul 2006).

At the end of these levels (layer 3 of area 1), the archeological remains are dated to around 13-12 ka BP. Burial places appeared in this area 1 and several human skeletons were found (Shoocongdej 2003, 2006, 2007; Pureepatpong 2004, 2006).

Overall, the last period of the late Pleistocene (layers 4 to 3) is the most important period at Tham Lod Rockshelter, because the archaeological remains are numerous and the lithic assemblages, are much better characterized as Hoabinhian than in the other layers. Consequently, it can be inferred that prehistoric people used to settle down for a longer period in this shelter, as hunters-gatherers, and they had a specialized tool kit more developed in technology as observed from the materials of area 2. Most of the mammalian taxa, found in this upper unit were related to those of the previous layers and indicated a forested environment. However the period between 20 and 12 ka is globally cooler and therefore dryer in the sub-tropical zones (decrease of summer monsoon). Therefore, the forest might not have been as dense as before. The population grew during this period because the climatic environment did not change drastically, remained forested and provided a suitable habitat for hunter-gatherer to exploit the surrounding forests for food (animal and vegetal) and for raw materials (wood, bamboo, etc.) during the end of the Pleistocene.

Holocene period

In the Holocene period, the cultural level 2 corresponds to the layer 2 of areas 1, 2 and 3, the ages of which are estimated to between 10 and 3 ka BP. These layers recorded the occupation of the shelter between the early Holocene and the late Holocene, but the middle Holocene was absent. Generally, the archaeological remains highlight well the Hoabinhian cultural assemblages, represented in several parts of Thailand (and Southeast Asia). The lithic assemblage of area 2 slightly decreased from the former layer 3. The fragments are abundant, especially the small fragments, which account for more than 65% of the assemblage. All the tools (large and small) are rare, but it is to be noted that a few sumatraliths were exposed in this layer. In contrast, blank flakes were well marked in this sequence **(Table 5.3.4e)**.

Only 10 mammalian taxa were identified, such as deer (*Cervus* sp.), wild pig (*Sus scrofa*), tiger (*Felidae*), carnivores (*Carnivora*), old world monkeys (*Cerophithecidae*), langur (*Colobinae*), porcupines (*Hystrix* sp.), serow (*Naemorhedus sumatraensis*) and Bamboo rats (*Rhyzomidae*) (Wattanapituksakul 2006). Two mammalian taxa - *Ursus thibetanus* and *Naemorhedis* sp. - are more abundant during this period, because they appeared in forests, especially the mixed deciduous forest, the hill evergreen forest and the limestone forest **(see in the appendix B: Tables 4 & 7)**.

According to Wattanapituksakul (2006), several mammals were continually exploited to the upper levels (layer 1) and their species are currently extant in Pang Mapha district, just like the types of forests, which would be similar to those of the current environment.

Therefore, the prehistoric people settled down for temporary periods, and less as hunter-gatherers because the climatic environment began to change in this area and because they would have begun to migrate to other regions in Thailand and Southeast Asia.

Periods	**Dates**	**Archaeological materials Area 2**			**Faunal remains Area 1****		**Floral remains (Area 1)*****	**Paleoenvironment ******
Area 2/ Layers	Estimated dates	Stone artefacts (Total number)	Actual tools (large & small): Total number	Mammals [Taxa]*	Area 1/ Layers	Mammals [NISP/MNI] & [Taxa: *Order/Family/Genus/ Species*]		Types of forest
10	35 ka BP	Flakes (27: 5%), Small tools (7: 1%), Large tools (11: 2%), Hammers (43: 8%), Big fragments (14: 3%), Small fragments (397: 76%) and Manuports (pebbles & cobbles) (25: 5%).	Choppers (11: 61%), scrapers (4) and Other small tools (3).		8a & 8			
9 Late Pleistocene	35-26 kaBP	Flakes (147: 13%), Small tools (39: 3%), Large tools (36: 5%), Hammers (41: 5%), Big fragments (11: 1%), Small fragments (475: 60%) and Manuports (pebbles & cobbles) (38: 5%).	Choppers (29: 39%), Sumatraliths (8: 11%), Parial sumatraliths (10: 13%), scrapers (19: 25%) and Other small tools (9: 12%).	Rhizomyidae, Ursidae, *Sus scrofa*, Bovidae, Naemorhedae, *Cervus unicolor*. Taxa: 6	6	Rhizomyidae, *Naemorhedus* sp., Bovinae, Rodentia, *Sus scrofa*, Cervidae. NISP/MNI: 23/6 Taxa: 6 (2/4/2/1)		Mixed deciduous forest, hill evergreen forest, bamboo forest, and limestone forest.
					7	Cervidae, Ungulates, and *Sus scrofa*. NISP/MNI: 10/4 Taxa: 3 (1/2/1/1)		Mixed deciduous forest.

Table 5.3.5a Synthesis of archaeological remains from Tham Lod Rockshelter, represented in the lower layers (10 to 9) dating to the late Pleistocene

Periods	**Dates**	**Archaeological materials Area 2**			**Faunal remains Area 1 ****		**Floral remains (Area 1) *****	**Paleoenvironment ******
Area 2/ Layers	Estimated dates	Stone artefacts (Total number)	Actual tools (large & small): Total number	Mammals [Taxa]*	Area 1/ Layers	Mammals [NISP/MNI] & [Taxa: *Order/Family/Genus/ Species*]		Types of forest
8 Late Pleistocene	33-25 ka BP	Flakes (179: 13%), Small tools (43: 3%), Large tools (60: 5%), Hammers (73: 5%), Big fragments (25: 2%), Small fragments (961: 70%) and Manuports (pebbles & cobbles) (30: 2%).	Choppers (49: 47%), Sumatraliths (11: 11%), Partial sumatraliths (7: 7%), scrapers (23: 22%) and Other small tools (13: 13%).	Rhizomyidae, Hystricidae, Rhinocerotidae, Ursidae, *Sus scrofa*, Bovidae, Naemorhedae, *Cervus unicolor*. Taxa: 8	5	Rhizomyidae, Rhizomys sp., Rodentia, *Cannomys badius*, *Bandicota indica*,*Ursus thibetanus*, Bubalus sp., *Naemorhedus* sp.,Boss sp., *Bubalus* sp., *Sus scrofa*, etc. NISP/MNI: 1140/96 Taxa: 29 (6/10/12/6)	*Pinus* sp., *Calocedrus* sp., Cyperaceae, Poaceae, Polypodiaceae, Pteridaceae, *Cyathea* sp., *Ophioglossum* sp., and Fagaceae.	Mixed deciduous forest, hill evergreen forest, bamboo forest, limstone forest, open forest/ grass field and swamp.

Acromyn and taxonomic symbols: MNI (Minimum number of individual)**,** NISP (Number of identified specimens)**,** sp. (Species)

* **Faunal remains, area 2** (Source: Amphansri 2004, 2005, 2011)

*** Faunal remains, area 1** (Sources: Amphansri 2004, 2005, 2011; Wattanapituksakul 2006)

**** Flora remain, area 1** (Sources: Treekanchanawattana & Pumijumnong 2005, Pumijumnong 2007)

***** Paleoenvironment** (Sources: Shoocongdej 2003, 2007, Khaokhiew 2004, Wattanapituksakul 2006)

Table 5.3.5b Synthesis of archaeological remains from Tham Lod Rockshelter, represented in the lower layers 8 dating to the late Pleistocene

Periods	**Dates**	**Archaeological materials Area 2**			**Faunal remains Area 1 ****		**Floral remains (Area 1)*****	**Paleoenvironment ******
Area 2/ Layers	Estimated dates	Stone artefacts (Total number)	Actual tools (large & small): Total number	Mammals [Taxa]*	Area 1/ Layers	Mammals [NISP/MNI] & [Taxa: *Order/Family/Genus/ Species*]		Types of forest
7	25 ka BP	Flakes (89: 7%), Small tools (28: 2%), Large tools (38: 3%), Hammers (9: 1%), Small fragments (1043: 83%) and Manuports (49: 4%).	Choppers (31: 47%), Sumatraliths (6: 9%), Partial sumatraliths (7: 11%), scrapers (18: 27%)	Rhizomyidae, Ursidae, *Sus scrofa*, Bovidae, Naemorhedae, *Cervus unicolor*. Taxa: 6		*Macaca* sp., Cercopithecidae., *Sus scrofa*., Cervidae., *Boss* sp.		
6 Late Pleistocene		Flakes (9: 4%), Small tools (31: 13%), Large tools (14: 6%), Hammers (2), Small fragments (165: 71%) and Manuports (11: 5%	Choppers (10: 22%), Sumatraliths (10: 22%), Partial sumatraliths (13: 29%), scrapers (8: 18% and other small tools (4)	Rhizomyidae, *Sus scrofa*, Bovidae, Naemorhedae, *Cervus unicolor*. Taxa: 5	4	Rhizomyidae, *Bubalus* sp., *Cannomys badius*, *Ursus thibetanus*, Rhinocerotidae, Bubalus sp., *Naemorhedus* sp., *Muntiacus* sp., Bovinae etc.		Mixed deciduous forest, hill evergreen forest, bamboo forest, limstone forest, open forest/ grass field, dense forest, low-lying forest, and swamp.
5	13 ka BP	Flakes (151: 22%), Small tools (14: 2%), Large tools (7: 1%), Hammers (1: 5%), Small fragments (501: 73%) and Manuports (11: 1%).	Choppers (5: 24%), Sumatraliths (4), Partial sumatraliths (3), scrapers (7: 33%) and Other small tools (2).	Rhizomyidae, Hystricidae, Ursidae, *Sus scrofa*, Bovidae, Naemorhedae, *Cervus unicolor*. Taxa: 8		NISP/MNI: 401/41 Taxa: 18 (6/9/9/4)		

Table 5.3.5c Synthesis of archaeological remains from Tham Lod Rockshelter, represented in the middle layers (7 to 5) dating to the late Pleistocene

Periods	**Dates**	**Archaeological materials Area 2**			**Faunal remains Area 1****		**Floral remains (Area 1)*****	**Paleoenvironment ********
Area 2/ Layers	Estimated dates	Stone artefacts (Total number)	Actual tools (large & small): Total number	Mammals [Taxa]*	Area 1/ Layers	Mammals [NISP/MNI] & [Taxa: *Order/Family/Genus/ Species*]		Types of forest
4 Late Pleistocene	24-13 ka BP	Total number: Flakes (430: 19%), Small tools (121: 5%), Large tools (79: 4%), Hammers (231: 10%), Big fragment (85: 4%), Small fragments (1271: 56%) and Manuports (48: 2%)	Total number: Choppers (33: 16%), Sumatraliths (41: 20%), Partial sumatraliths (34: 17%), scrapers (56: 28%) and Other small tools (36: 18%)	Rhizomyidae, Hystricidae, Ursidae, *Sus scrofa*, *Boss* sp., Bovidae, Naemorhedae, *Muntiacus* sp., *Cervus unicolor*. Taxa: 9	3	Colobinae., Rodentia., Rhizomyidae, *Bubalus* sp., *Cannomys badius*, *Ursus thibetanus*, Rhinocerotidae, Bubalus sp., *Sus scrofa*., *Naemorhedus* sp., Ungulates, *Muntiacus* sp., *Cervus unicolor* etc.	*Pinus* sp., *Calocedrus* sp., Cyperaceae, Poaceae, Polypodiaceae, Pteridaceae, *Cyathea* sp., *Ophioglossum* sp., and Fagaceae	
3	13-12 ka BP	Total number: Flakes (345: 10%), Small tools (128: 3%), Large tools (138: 4%), Hammers (341: 9%), Big fragment (184: 5%), Small fragments (2409: 67%) and Manuports (64: 2%)	Total number: Choppers (86: 32%), Sumatraliths (37: 14%), Partial sumatraliths (57: 21%), scrapers (53: 20%) and Other small tools (33: 12%)	*Sus scrofa*, *Boss* sp., Bovidae, Naemorhedae, *Muntiacus* sp., *Cervus unicolor*. Taxa: 6		NISP/MNI: 69/17 Taxa: 10 (4/5/5/3)		Mixed deciduous forest, hill evergreen forest, bamboo forest, limstone forest, open forest/ grass field, dense forest, low-lying forest, and swamp.

Table 5.3.5d Synthesis of archaeological remains from Tham Lod Rockshelter, represented in the upper layers (4 to 3) dating to the late Pleistocene

Periods	**Dates**	**Archaeological materials Area 2**			**Faunal remains Area 1****		**Floral remains (Area 1)*****	**Paleoenvironment ******
Area 2/ Layers	Estimated dates	Stone artefacts (Total number)	Actual tools (large & small): Total number	Mammals [Taxa]*	Area 1/ Layers	Mammals [NISP/MNI] & [Taxa: *Order/Family/Genus/ Species*]		Types of forest
2 Holocene	10-3 ka BP	Total number: Flakes (147: 13%), Small tools (41: 14%), Large tools (15: 1%), Hammers (24: 2%), Big fragment (27: 2%), Small fragments (848: 77%) and Manuports (9: 1%)	Total number : All tools (42: 5%)	?	1	*Ursus thibetanus*, *Naemorhedus* sp.,*Cervus* sp., *Sus scrofa*, *Felidae*, *Carnivora*, *Cerophithecidae*, *Colobinae*, *Hystrix* sp., *Naemorhedus sumatraensis*, *Rhyzomidae* etc. NISP/MNI: 69/17 Taxa: 10 (4/5/5/3)		Mixed deciduous forest, hill evergreen forest, and limestone forest.

Acromyn and taxonomic symbols: MNI (Minimum number of individual)**,** NISP (Number of identified specimens)**,** sp. (Species)

* **Fuanal remains, area 2** (Source: Amphansri 2004, 2005, 2011)

**** Faunal remains, area 1** (Sources: Amphansri 2004, 2005, 2011; Wattanapituksakul 2006)

***** Flora remain, area 1** (Sources: Treekanchanawattana & Pumijumnong 2005, Pumijumnong 2007)

****** Paleoenvironment** (Sources: Shoocongdej 2003, 2007, Khaokhiew 2004, Wattanapituksakul 2006)

Table 5.3.5e Synthesis of archaeological remains from Tham Lod Rockshelter, represented in the top (layer 2) dating to the of Holocene

5.4 Discussion

This dissertation deals with the analysis of a sample of lithic artefacts from Tham Lod Rockshelter in Northwestern Thailand. The stone artefacts studied have not been selected at random, but from the center of the excavation in sectors S20W10 and S21W10 of area 2. They are from the entire stratigraphic sequence occurring in these two sectors, especially from the late Pleistocene layers, while those from upper layer 2, dating to the Holocene, have not been dealt with in detail for this thesis, but have been presented in the data base (**see appendix A)**.

The activities of the prehistoric dwellers were certainly not only adjacent to the wall, just below the overhang of the cliff (area 1), but could also take place some 10 to 20 m apart (area 2 and 3): faunal remains, especially, are much more abundant in area 1 as well as fire places (Shoocongdej 2002, 2003, 2004, 2005, 2006, 2007; Khaokhiew 2003; Ampansri 2004, 2005; 2011; Wattanapituksakul 2006; Marwick 2008; Marwick & Gagan 2011). However, the sectors studied in this thesis and the number of stone artefacts are very small compared to the entire excavation (10-15%).

This study sheds more light on the technical features of the lithic assemblages during late Pleistocene, from about 35 ka BP to 12 ka BP **(Tables 2.5.8a, b and 2.5.9)**. The interpretation of this lithic industry is enhanced by placing it in the context of other associated materials, particularly a rich collection of faunal remains within a well-defined stratigraphy and also by the comparison with other prehistoric sites in Thailand and Southeast Asia.

Analyses of the lithic materials from two sectors of area 2 at Tham Lod show that the distribution of the artefacts is highly variable in quantity and nature according to their location in the site, even for two adjacent sectors. As a whole, this industry is mainly comprised of rocks collected from the nearby river bank, especially gray sandstone which represents more than 90% in all the layers. Small amounts of black sandstone, quartzite, siliceous shale and quartz, etc., also occur. In the studied area - sectors S20W10 and S21W10 - the lithic material is characterized by numerous large and small rock fragments (70%) and also by manufactured products (flakes and core tools). There is an abundance of tools, especially in the upper layers 3 to 4, where they are well shaped, more than in other layers in area 2.

The data regarding flake production do not differ noticeably between sectors. Actually, the flake assemblage from Tham Lod Rockshelter matches the by-products of experimental manufacture of Hoabinhian tools (Jérémie, Vacher 1992; Marwick 2008; **chapter 5.2 here above**). The proportion of totally cortical flakes (9 to 13%), partly cortical flakes (34 to 44%) and non-cortical flakes (48 to 70%) can be compared with the proportions resulting from experimental production of large tools **(see chapter 5.2),** mostly sumatraliths (respectively 7%, 33% and 60%); these are similar to Jérémie's and Vacher's (1992) experimental production (11%, 34% and 53%, plus 2% undetermined).

In addition, the longest of the scars shaping the large tools have been measured on each specimen from sectors S20W10 and S21W10 of area 2, to evaluate the maximum size of flakes resulting from their manufacture. The average length of the flakes is around 40 mm while the longest removals observed on the choppers and sumatraliths measure 30-40 mm in average length. Longest scars are, in average, slightly bigger than flakes. Therefore it can be inferred that most of the flakes result from the shaping, trimming and resharpening of large tools, and all these activities were all performed at the site.

There may be some flakes that are not simply the by-products from shaping, especially in the lower layer 10, but these are proportionally few.

However, the very high proportion of fragments in all layers remains to be determined, and this may require the contribution of other disciplines in the study of Tham Lod Rockshelter. Thermal effects are suspected for some of the specimens but cannot explain all the fractures.

Overall, the flakes from Tham Lod Rockshelter have no conspicuous edge damage and this further indicates that they were just by-products and were not made for being used, but some flakes with use-damage on the striking platform might have been removed from heavy-duty tools to re-sharpen damaged edges. However utilized or retouched flakes are also present at Tham Lod Rockeshelter, but they are rare in the studied sectors. They occur in the form of different small tools such as scrapers, denticulates, beaks or pointed tools and atypical small tools. These light-duty tools, mainly scrapers, are larger (bigger) than the blank flakes **(Table 4.3.3)**. Obviously, the production of flakes by reduction of proper cores, if at all this operation was performed, was not intended to feed the pool of blanks for scrapers. Broken cobbles were preferred, except for the few scrapers from lower layer 10 (4 only) whose supports are flakes or fragments, while in the overlying layers they are mostly cobbles and broken cobbles. It then appears that there is continuity between the choppers and the scrapers. The limit between heavy-duty and light-duty tools may be around 80-90 mm long and 70-80 mm wide (bimodal histograms), not at 100 mm as arbitrarily admitted. Smaller dimensions (< 80 mm) may correspond to real light-duty tools. It is not the same with the blank flakes as the histogram of length is clearly unimodal with a mode (peak) at 30-40 mm.

The flakes also contribute to differences between the lower and upper layers. Their striking platform is less often cortical in the former than the latter, suggesting that bifacial flaking, or flaking using fractures as striking platforms, is more frequent in the lower layers. This may be related to the higher occurrence of broken or split cobbles among the supports of the heavy-duty tools in the lower layers.

In the upper layers, shaping of the sumatraliths (usually made on flat cobbles) mostly provides flakes with cortical butts. The flake scar pattern on the dorsal face of the flakes also shows some change between lower and upper layers. Throughout the sequence they are mostly unipolar and this fits the model of flakes produced by marginal shaping of large tools, especially choppers. Only in the few cases of medium to invasive shaping of the sumatraliths or multiple choppers do the removals encroach scars on another side and display bidirectional or multidirectional dorsal patterning. Bidirectional patterns, slightly more frequent in the upper layers, may be related to shaping of sumatraliths. The convergent pattern of the flakes would fit well with the diversity of the choppers. In the lower layer 10, these frequent diversified choppers possibly correspond to proper cores (production of flakes) instead of tools (assistance to the hand in any activity) suggesting an intentional production of flakes, moreover slightly larger than in the other layers. Although the material is not abundant (and therefore may not be statistically representative), it seems that the raw materials are more diversified in this lower layer. It is to be noted that pounding marks are more frequent on the choppers from layers 10 and 9 than in the upper layers.

As for the typical Hoabinhian tools, their frequency remains rather low, not more than 10% of the tools (large and small) in the lower layers 9 to 7. From layer 6 upwards it exceeds 20%, except in the upper layer 3 where it decreases again. The partial sumatraliths follow the same trend. Correlatively the choppers are dominant among the large tools in the lower layers and they decrease to the increase of sumatraliths in the upper layers, except in layer 3. Sumatraliths appear in layer 9, dating to more than 26,600 years B.P. (Shoocongdej 2003, 2006, 2007) but seem to be absent in the lower layer 10, where yet the amount of lithic artefacts is very small, and this observation may not be strong proof of absence (Chitkament et al. 2015).

Typical Hoabinhian tools flourish in layers 4 to 6, in a time period dating approximately from 24,000 years BP onwards; climatic conditions were quite humid although unstable, driving a constantly forested landscape up to 20,000 years B.P. (Marwick, Gagan 2011, Penny 2001, Rashid et al. 2007); this might have favored recurrent occupations of the shelter (in layer 4), before the cold event of LGM and the even colder Heinrich 1 event. The other heavy-duty tools are various types of choppers; these are not diversified in the upper layer 3 where they are mostly end and side choppers, with single or double transversal edges possibly having the same function as the sumatraliths.

As demonstrated for other assemblages from this region, three *chaînes opératoires* are used to produce Hoabinhian assemblages (Forestier et al. 2005, 2008, 2013 and Zeitoun et al. 2008). They all imply the selection of cobbles for raw material, and at Tham Lod Rockshelter these are easily available near the site. The simplest process is to directly shape the selected cobbles into either choppers or sumatraliths. Choppers are slightly thicker (50-55 mm) than the sumatraliths (around 40 mm). Thus, right from the stage of support selection two technical sequences were distinguished. The third sequence, which was not frequently used at Tham Lod, consist in fracturing the cobbles, approximately following the grand plan (split) in order to obtain two supports for shaping various types of tools, including smaller tools like scrapers.

These three processing sequences are observed throughout the stratigraphy at Tham Lod, from about 35 to 10 ka B.P. Climate changes do not seem to have affected this technical tradition. Does the decrease in number of sumatraliths in the layer 3 correspond to the LGM, where the vegetation was characterized by pine/ oak forest (White et al. 2004)? Multidisciplinary study of the archaeological and environmental record at Tham Lod may answer these questions **(Tables 5.1.5a, 5.1.5b, 5.1.5c, 5.1.5d and 5.1.5.e)**.

In addition, the extent of reduction of core or the technical efforts invested in the production of a tool can be driven by other factors than just the accessibility to the raw materials; the technical tradition and the cultural context are certainly involved. Accessibility to mineral and vegetal raw materials, as well as to subsistence resources might have changed according to the climatic context. Floods, for instance, might have hampered or stopped access to the river cobbles, as well as the cold seasons, during which prehistoric people probably preferred to stay near hearth fire and re-sharpen their tools rather than foraging just to collect fresh cobbles. While such anecdotal events are, of course, not recorded in the site, they inferred on the day to day life of hunter-gatherers. Anyway, the long-term environmental changes linked to global climate variations are not easy assessable in the stratigraphy of Tham Lod, due to a complex chronological record. The last glacial maximum (LGM) with average temperatures 5°C to 7°C lower than today (NguyenViet 2008) is probably included in the layer 3, or in the top of layer 4 (area 2), with other warmer events blurring the possible human behavioral response.

Analysis of $\delta^{18}O$ in freshwater bivalve shell along the entire sequence at Tham Lod shows that the climate was wet and instable before the LGM and became dryer from about 20,000 years ago until the Holocene (Marwick and Gagan 2011; **figure 5.4.1**).

However, this climate change may not have significantly impacted vegetation, as it was mainly composed of adaptable taxa, tolerant to dryer and cooler conditions; significant changes in the vegetation only occurred at the Pleistocene to Holocene boundary, yet maintaining forested landscapes (Penny 2001).

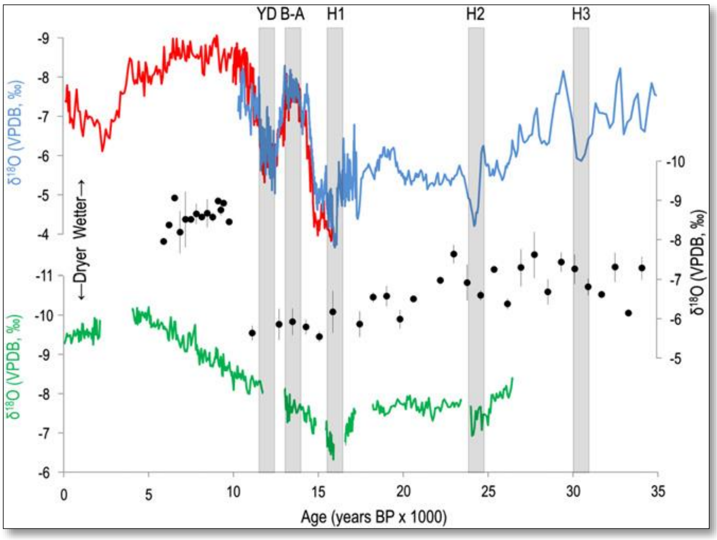


Figure 5.4.1 Tham Lod and Ban Rai $\delta^{18}O$ sequence (black circles with standard error bars) compared to Hulu Cave (blue, Wang et al., 2001) and Dongge Cave (red, Yuan et al., 2004) records in China, and to Gunung Buda Cave record from Malaysian Borneo (green, Partin et al., 2007).

(Source: Marwick and Gagan 2011)

The apparent technical stability of the Hoabinhian techno-complex crosses these climatic and /or environmental boundaries. As proposed by many authors, this technical tradition or this "industry" may be linked to wood-and bamboo-working (Forestier 2000, 2003, Hutterer 1976; Pope 1989, White and Gorman 2004, 2011). More than any other environmental component, the forest environment, whatever type of forest, is probably the most important factor in the longevity of the Hoabinhian tradition.

According to Kukla (1981) and Anderson (1990), the worldwide climate has changed significantly since the Last Glacial Maximum, and has been widely recognized for decades. For East and Southeast Asia, the various lines of palaeoenvironment evidence (climate change) are more apparent in some region, especially mainland Southeast Asia. The environment was affected by sea level changes and it was cool climate during late Pleistocene and early Holocene. Paleontologists and palynologists have noted that modern environmental conditions, as defined by the presence of a fully recent faunal and floral assemblage, were already in place in Southeast Asia by at least 40,000 years ago (Anderson 1990: 73). Paleontologists and archaeologists have avoided these subjects possibly because late Pleistocene and early Holocene climatic changes were not accompanied by major animal turnover, the ecological variable that is often regarded as critical to the course of early human prehistory (Martin and Klein 1984, Anderson 1986).

5.5 Conclusion

These disseration has tried to approach, through analysis of their lithic industry, the way of life of hunter-gatherers who settled in Tham Lod Rockshelter of Pang Mapha district, Mae Hong Son province, Thailand. This investigation was made possible by the variety of archeological evidence from the excavations carried out by R. Shoocondej and the staff of Highland Panga Ma Pha Project between 2001 and 2006. Considering all the data from several sets of analyses leads to draw some conclusions concerning the prehistoric people living in north-western Thailand in the late Pleistocene and early Holocene

The archaeological material from Tham Lod Rockshelter amounts to more than 100,000 artefacts recovered from the excavation. The lithic material from sectors S20W10 (SEQ 3-4) and S21W10 (SEQ 3-4) comprised of 10,740 items has been analysed in detail in the present work. Among these artefacts, about 70% are fragments whose origin may not result from strict knapping activity of the dwellers at Tham Lod. Flakes mainly result from the shaping and sharpening of the large tools / heavy-duty tools and these activities were entirely performed at the site. Only very few flakes are retouched into small tools: these are mainly made from broken cobbles and pebbles. The large tools (less than 10%), usually made on cobbles from the nearby river, are mainly comprised of choppers and sumatraliths; the latter are recorded in largest number in the upper layers and attest that the assemblages belong to the Hoabinhian techno-complex.

The stratigraphic sequence of Tham Lod Rockshelter has recorded the Late Pleistocene environmental conditions since 35 ka B.P. (bottom layer 10 in area 2). From this sequence, the faunal and floral remains as well as sedimentological data provide information about palaeo-environments and palaeo-climate in Pang Mapha district. It was mostly under tropical to sub-tropical conditions with the inclusion of colder and drier spells during the late Pleistocene. However the cold events of Last Glacial Maximum and Heinrich 1 do not appear as drastic changes, or were not recorded, apart from the rock fall (layers 7 to 5 in area 2) that may be due to them. These factors led to the permanence of the forest and to the survival of various mammals, which persist till now as relic species in Thailand and Myanmar, where currently exists a more sub-tropical climate with warmer and wetter conditions. In Tham Lod Rockshelter the lithic industry slowly evolves from an assemblage apparently devoid of sumatraliths, the unifacial tools specific of the Hoabinhian technical tradition, to an assemblage where these tools are typical and well developed (layer 4), while they slightly decrease in the last Pleistocene level (layer 3). The relative stability of the forested landscape during the Late Pleistocene may be one of the main reasons for the apparent stability of the technical tradition, which are deprived of their vegetal component and only reflected by the lithic assemblages. This stability attests the perfect adaptation of the prehistoric populations to their environment.

References

Adi, B.H.T., 1983. Recent Archaeological Discoveries in Peninsular Malaysia 1976-1982. *Journal of the Malaysian Branch, Royal Asiatic Society* 56: 47-63.

Allen, J., Golson, J., and Jones, R., 1977. "Sunda and Sahul" *Prehistoric studies in Southeast Asia, Melanesia and Australia*. Academic Press.

Aid, H.T., 1985. The re-excavation of the Rockshelter of Gua Cha, Ulu Kelantan, West Malaysia. *Federation Museum Journal* Vol. 39.

Amphansri, A., 2004. Faunal analysis. In: Shoocongdej, Rasmi (Ed.). *Progress Report II. Highland Archaeological Project in Pang Mapha Phase II*, submitted to Thailand Research Funds (TRF). (In Thai)

Amphansri, A., 2005. Faunal analysis. In Shoocongdej, Rasmi (Ed.). *Progress Report III. Highland Archaeological Project in Pang Mapha Phase II*, submitted to Thailand Research Funds (TRF). (in Thai)

Amphansri, A., 2011. Temporal and spatial analysis of faunal remains from Tham Lod Rockshelter site, Pang Mapha District, Mae Hong Son Province, Unpublished thesis (M.A), Department of Archeology, Silpakorn University. (in Thai)

Anderson, D., 1986. *Lang Rongrien a Rockshelter site from Krabi, South western Thailand*: Report of excavation 1983-1985. National geographic society, Washington, D.C. and National research council, Thailand.

Anderson, D., 1987. A Pleistocene-Early Holocene Rockshelter in Peninsular Thailand. National Geographic Research, 3 184-198.

Anderson, D., 1987b. A late Pleistocene-early Holocene archaeological site in Southwestern Thailand and its implications for climatic change. In: *Preceesings of the workshop on economic geology, tectonics, Sedimentary Processes and Environment of the Quaternary in Southeast Asia,* edited by N. Thiramongkol, pgs, 213-229. Bangkok: Department of Geology, Chulalongkorn University.

Anderson, D., 1988. *Excavations of a Pleistocene rockshelter in Krabi and the Prehistory of southern Thailand, In Prehistoric Studies*: The stone and metal ages in Thailand, edited by P. Chareonwongsa and B. Bronson, pgs, 43-59. Bangkok: the Thai Antiquity Working Group. 1990.

Anderson, D., 1990. Lang Rongrien rockshelter: *A Pleistocene –early Holocene archaeological site from Krabi, southwestern Thailand*. The University Museaum, University of Pennsylvania, Philadephia, U.S.A. Printed in the United States of America.

Anderson, D., 1997. Cave archaeology in Southeast Asia. *Geoarchaeology* 12 (6): 607-38.

André Leroi-Gourhan., 1964. Les religions de la Préhistoire, Paris, PUF (rééd. 1971 et 1976).

Auetrakulvit, P., 1995. The technology analysis of the lithic samples: A case study from Archaeological excavation at Moh Khiew Rockshelter II, Amphoe Muang, Krabi Province, Unpublished thesis (M.A), Silpakorn University, Bangkok, Thailand. (in Thai)

Auetrakulvit, P., 2004. Faunes du Pléistocène final à l'Holocène de Thaïlande : Approche archaéozoologique, Thèse doctorale, Université Aix-Marseille I - Université de Provence U.F.R. civilisation et Humanité.

Auetrakulvit, P., 2004. The subsistence of prehistoric man during late Pleistocene-early Holocene in Southern Thailand. *A Proceeding of Thailand-Malaysia: Malay Peninsula Archaeology Programme*. 4-10 September 2004.

Auetrakulvit, P., 2006. The late Pleistocene and Holocene fauna of Thailand: an archaeozoological approach. Department of Archaeology, Silpakorn University, Bangkok, Thailand.

Auetrakulvit, P., Forestier, H., Khaokhiew, C., Zeitoun, V., 2012. New Excavation at Moh Khiew Site (Southern Thailand). In: Tjoa-Bonatz, D., Reineck, A., Tjoa-Bonatz, M.L. (eds.), *Crossing Borders: Selected papers from the 13th International Conference of European Association of Southeast Asia Archeologists*. Singapore: NUS Press. pp. 62-74.

Bannanurag, R., 1988. Evidence for ancient woodworking: a microwear study of Hoabinhian tools. In: *Prehistoric studies: the stone and metal ages in Thailand*, edited by P. Chareonwongsa and B. Bronson, pgs. 61-79 Bangkok. The Antiquity Working Group.

Barnes, J., 1990. Bibligraphical review of far eastern archaeology 1990 "*Hoabinhian, Joman, Yayoi early Korean states*" Oxbow books.

Barr, S.M., A.S. Macdonal, N.S. Haile, and P.H. Reynolds., 1976. Paleomagnetism and Age of the Lampang Basalt (Northern Thailand) and Age of the Underlying Pebble Tools. *Journal of Geological Society of Thailand*, 2 (1-2): 1-10.

Bar-Yosef, O. and P. Van Peer., 2009. The chaîne opératoire approach in Middle Paleolithic archaeology. Current Anthropology 50: 103-131.

Baum, F. et al., 1970. On the geology of Northern Thailand. Beih. Geol. J., Hannover 102, 1-24 + 1geol map 1: 1 mio.

Bayard, D.T., 1968. Preliminary Report on the University of Hawaii, Excavation at Non Nok Tha, Pu wiang, Khon Kaen, Thailand: Febuary to March (1968).

Bayard, D.T., 1970. Excavation of Non Nok Tha, Northeast Thailand, 1968: An interim report. *Asian Perspective*, vol. xxx, 109-144.

Bayard, D.T., 1984. A checklist of Vietnamese radiocarbon dates. In *The Original of Agriculture, Metallurgy, and the state in Mainland Southeast Asia*, (eds.) by D. Bayard. University of Otago Studied in Prehistoric Anthropology 16: 305-322.

Bellwood, P., 1985. Prehistory of Indo-Malaysia Archilpelago. The Australian National University, Academic Press, Australia.

Bleed, P., 2001. Trees or chains, links or branches: conceptual alternatives for consideration of stone tool production and other sequential activities. *Journal of Archaeological Method and Theory* 8 (1): 101-128.

Boëda, E., 1986. Le débitage Levallois de Biache-Saint-Vaat (Pas-de-Calais) : première étude technologique, in chronostratigraphie et faciès culturels de Paléolithique inféricur et moyen dans l'Europ du nord-ouest, pp. 209-218. Supplèment de Bulletin de l'Association française pour l'Europe du Quaternaire, n° 26.

Boëda, E., J.M. Geneste and L. Meignen., 1990. Identification de chaînes opératoires lithiques du Paléolithique ancien et moyen, *Paléo: Revue d'Archéologie Préhistorique* 2: 43-80.

Bordes, F., 1950. Principes d'une méthode d'étude des techniques de débitage et de la typologie du Paléolithique ancien et moyen. *L'Anthropologie*, *54* (1-2), 19-34.

Bordes, F., 1961. *Typologie du Paléolithique ancien et moyen*. Cahiers du Quaternaire, 1, 2 vol., CNRS Éditions, rééd. 2000, 101p.

Borskovsky, P.I., 1967. Problems of the Paleolithic and the Mesolithic of Southeast Asia. In *Archaeology at the Eleventh Pacific Science Congress*, Wilhelm G. Solheim II, ed., pp.41-46. Asian and Pacific Archaeology Series, No. 1. Honolulu: Social Science Research Institute, University of Hawaii.

Brandt, R.W., 1987. Hoabinhian of Sumatra: Some remarks. *Modern Quaternary Research in Southeast Asia* 2: 49-52.

Braun, E. and Hahn, L., 1976. Geological map of Northern Thailand, sheet 2, Chiang Rai, scale 1: 250,000. Fed. Inst. Geosci. & Nat. Res., Hemmingen.

Bronson, B., 1987. Models for Southern Thai- Pre-and Proto History. Appendix 7d *of SPAFA Seminar in Prehistory of Southeast Asia (T-W11)*, pgs. 259-266. Bangkok, Surat Thani, Phangnga, Phuket, and Krabi, Thailand; 12-25 January 1987.

Bronson, B. and Asmar, T., 1976. Prehistoric investigations at Tianko Panjang cave. Sumatra: an interim report. *Asian Perspectives* (1975) 18: 128-145.

Bronson, B. and Glover, I.C., 1984. Archeological radiocarbon dates from Indonesia: a first list. *Indonesion Circle* 34: 37-44.

Bronson, B. and Charoenwongsa P., 1988. Introduction: Prehistoric Chronology in Thailand. In P. Charoenwongsa and B. Bronson (eds), *Prehistoric Studies: The stone and Metal Ages in Thailand*, pg. 9-15. Bangkok: The Thai Antiquity Working Group.

Bronson, B. and Natapintu, 1988. Don Noi: a new flaked tool industry of the middle Holocene in western Thailand. In: P. Charoenwongsa and B. Bronson (eds), *Prehistoric Studies: The stone and Metal Ages in Thailand*, pg. 91-106. Bangkok: The Thai Antiquity Working Group.

Bronson, B., J. White., 1992. “Radiocarbon and Chronology in Southeast Asia”. In *Chronologies in Old World Archeology*, Vol.1 and 2, ed. R.W Ehrich. Chicago: University of Chicago Press, 491-503 (Vol.1), 475-515 (Vol. 2).

Brown, W.L., and E.O. Wilson., 1956. Character displacement. *Systematic Zoology 5: 49-64.*
Buikstra, J.E., and Ubelaker, D.H., 1994. (eds.) *Standards for data collection from Human Skeletal remains*. In: Arkansas Archeology Survey Research Series No. 44. Fayetteville: Arkansas Archeology Survey.

Bulbeck, F.D., 2003. Hunter-gatherer occupation of the Malay Peninsula from the Ice Age to the Iron Age. In Mercader, J. (Ed.) *Under the Canopy*: *The Archeology of Tropical Rainforests*. Piscataway, NJ: Rutgers University Press.

Carbonell, E, *et alii*., 1985. *Sota Palou-Campdevanal. Un centre d’intervenció prehistórica postglaciar a l’aire lliure.* Girona : Diputació Girona.

Carbonell, E., Mosquera, M., Ollé, A., Rodríguez, X.P., Sala, R., Vaquero, M., Vergés, J.M., 1992. New elements of the Logical Analytic System. *Cahier Noir* 6, Reial Societat Arqueològica Tarraconense, Tarragona, p 61.

Carbonell, E. & Rodrı´guez, X. P., 1994. Early Middle Pleistocene deposits and artefacts in the Gran Dolina site (TD4) of the ‘‘Sierra de Atapuerca’’ (Burgos, Spain). *J. hum. Evol.* 26, 291–311.

Carbonell, E., Esteban, M., Na´jera, A. M., Mosquera, M., Rodrı´guez, X. P., Olle´, A., Sala, R., Verge`s, J. M., Bermu´dez de Castro, J. M. & Ortega, A. I., 1999. The Pleistocene site of Gran Dolina, Sierra de Atapuerca, Spain: a history of the archaeological investigations. *J. hum. Evol.* **37,** 313–324.

Chaimanee, Y., 1994. Mammalian Fauna from Archaeological Excavations at Moh Khiew Cave, Krabi Province and Sakai Cave, Trang Province, Southern Thailand. In Pookajorn, S (ed.) *Final Report: The Hoabinhian Research Project of Thailand (Phase 2)*. Bangkok: Silpakorn University Press.

Chang, K.C., 1971. Review of “Changpinian: A newly discovered preceramic culture from Agglomeritic Caves on the East Coast of Taiwan (Preliminary report)” by Wen-hsun Sung, with appendix “Archeologists Rediscovering Taiwan” *Asian Perspectives* (1969) 12: 133-136

Chang, K.C., 1977. *The Archaeology of Ancient China*. (3rd ed.) Yale University Press.

Charoenwongsa, P., 1984. Archaeology of the Mea Moh Basin, Lampang. *Main Report of the Mae Moh Project*: *Environmental and Ecological studies and Impact Assessment* 116-142. Electricity Generating Authority of Thailand, Bangkok.

Charoenwongsa, P., 1987. Developments in prehistoric Thai archaeology. *Man and Culture in Oceania* 3: 79-89.

Charoenwongsa, P., 1988. The Current Status of Prehistoric Research in Thailand. In P. Charoenwongsa and B. Bronson (eds), *Prehistoric Studies: The stone and Metal Ages in Thailand,* pg. 17-41. Bangkok: The Thai Antiquity Working Group.

Cheng, T-K., 1957. *Archaeological Studies in Szechuan*. Cambridge University Press.

Cheng, T-K., 1959. *Prehistoric China*. Archaeology in China, Vol. 1. Cambridge: W. Heffer and Sons, Reprinted with corrections, 1966; Supplement 1966.

Chinh, H.X., 1984. Hoabinhian culture and the birth of botanical domestication in Viet Nam. In: *The Origins of Agriculture, Metallurgy, and the state in Mainland Southeast Asia*, edited by D. Bayard. Southeast Asian Archaeology at the XV Pacific Science Congress, University of Otago. Studies in Prehistoric Anthropology 16: 169-172.

Chitkament, T., 2007. Master dissertation *"Lithic analysis of Moh Khiew Rockshelter (Locality I) in Krabi River Valley in Krabi River Valley, Krabi province, Southwestern Thailand*". Department of History of Universitat Rovira I Virgili (URV), Tarragona, (Spain), and Department of prehistory in the National Museum of Natural History (MNHN), Paris, (France).

Chitkament T., Gaillard C., & Shoocongdej R., (submitted in 2012)
Evolution of the lithic industry from Tham Lod Rockshelter (Pang Mapha district, North-western Thailand) during the Late Pleistocene: preliminary results. In: *Lewis H. (ed.), Selected Papers from the 14th International Conference of the European Association of Southeast Asian Archaeologists,* NUS Press, Singapore.

Chitkament T., Gaillard C., & Shoocongdej R, 2015. Tham Lod Rockshelter (Pang Mapha district, North-western Thailand), Evolution of the lithic assemblages during the Late Pleistocene. *Quaternary International* xxx: 1-11 (in press).

Choowong, M., 2002. The geomorphology and assessment of indicators of sea-level changes to study coastal evolution from the gulf Thailand. The Department of Mineral resource Bangkok, Thailand.

Clark, DL., 1978. Analysis Archaeology; *Second edition by Bob Chapman*; J.W. Arrowsmith Ltd, Bristol.

Colani, M., 1926. Découverte d'industries paléolithiques dans la province de Hoa- Binh (Tonkin). *L' Anthropologie* 36: 609-611. (in French).

Colani, M., 1927. L´âge de la Pierre dans la province de Hoa Binh (Tonkin). Mémoires du service géologique de l´Indochine, vol 14, fasc.1, 95 p (in French).

Colani, M., 1927a. Découverte du Paléolithiques dans le province de Hoa- Binh (Tonkin). *L' Anthropologie* 37: 147-149. (in French).

Colani, M., 1927b. Découverte de la grotte sépulcrale de Lang-Gao (Province de Hua-Bin, Tonkin). *L' Anthropologie* 37: 227-229. (in French).

Colani, M., 1931. Recherches sur le préhistorique Indochinois. *Bulletin de L'Ecole Française D'Extrême-Orient* 30: 299-422. (in French).

Conrad, C., Van Vlack. H., Marwick, B., Thongcharoenchaikit, C., Shoocongdej, R. and Chaisuwan, B., 2013. Summary of vertebrate and molluscan assemblages excavated from late- Pleistocene and Holocene deposits at Khao Toh Chong Rockshelter, Krabi, Thailand. *The Thailand Natural History Museum Journal*, 7 (1): 11–21.

Crabtree, D., 1975. Comments on lithic technology and experimental archaeology. In: E. Swanson (ed.), *Lithic technology*. Chicago. Aldine Press.

Davis, M.B., 1981. Quaternary history and the stablility of forest communities. In: D.C. West, H.H. Shugardt and D.B. Botkin (eds.). *Forest Succession*. pp 132-153. Spring, New York.

Demeter, F., Laura L., Shackelford, Anne-Marie Bacon, Philippe Duringer, Kira Westaway, Thongsa Sayavongkhamdy, José Braga, Phonephanh Sichanthongtip, Phimmasaeng Khamdalavong, Jean-Luc Ponche, Hong Wang, Craig Lundstrom, Elise Patole-Edoumba and Anne-Marie Karpoff., 2012. Anatomically modern human in Southeast Asia (Laos) by 46 ka. *Proceedings of the National Academy of Sciences of the United States of America*. Vol. 109, No. 36 (September 4, 2012), pp. 14375-14380

Dunn, F.L. 1964., Excavations at Gua Kechil, Pahang. *Journal of the Malaysia Branch Royal Asiatic Society*; Vol 77., P. 87-124.

Dunn, F.L. 1966., Radiocarbon dating of the Malayan Neolithic, Proceedings of the Prehistoric Society 32: 352-353.

Dunn, F.L. 1970., Culture evolution in the late Pleistocene and Holocene of Southeast Asia. *American Anthropologist* 72: 1041-1054.

Even, I.H.N., 1926. "An Ethnological Expedition to South Siam. *Journal of the Federated Malay States Museums*, 12, part 2.

Even, I.H.N., 1927. Paper on the Ethnology and Archaeology of the Malay Peninsula. Cambridge University Press.

Fine Arts Department., 1987. The survey Report of Mae Hong Son Province. Unpublished report. Department of Fine Arts, Bangkok. (in Thai).

Fine Arts Department., 1988. *Archeology of Four Regions*. Bangkok: Hattasin. (in Thai).

Fine Arts Department., 1991. *Archaeology of North Thailand*. Bangkok: Rongpim Karn Satsana, (in Thai).

Forestier, H., 2000. De quelques chaînes opératoires lithiques en Asie du Sud-Est au Pléistocène supérieur final et au début de I'Holocène, L'Anthropologie, 104, pp. 537-548.

Forestier H., 2003. Des outils nés de la forêt. De l'importance du végétal en Asie du Sud-Est dans l'imagination et l'invention technique aux périodes préhistoriques. In: *Froment A. & Guffroy J. (eds.) Peuplements anciens et actuels des forêts tropicales : actes du séminaire-atelier*. *Orléans, 15-16 octobre 1998*. IRD Editions, Paris. 315–337.

Forestier, H., Zeitoun, V. et al., 2006. Discovery of new old material in the basaltic region of Lampang (Northern Thailand): A techno-function interpretation. In Archaeology in Southeast Asia "From homo erectus to the living tradition" *Choice of paper from the 11th International conference of the European Association of Southeast Asia Archaeology*. Edited by Pautreau, J.P., Sophie, A., Zeitoun, V.,and Rambault, E.

Forestier, H., Simanjuntak, H.T., Guillaud, D., Driwantoro, D., Wiradnyana, K., Siregar, D., Due Awe, R., Budiman, 2005a. Le site de Tögi Ndrana, île de Nias, Sumatra Nord: les premières traces d'une occupation hoabinhienne en grotte en Indonésie. C. R. Palevol 4, 727–733.

Forestier, H., Zeitoun, V. et al., 2006. The Hoabinhian site of Huai Hin (Northern Thailand). In: Archaeology in Southeast Asia "From homo erectus to the living tradition" *Choice of paper from the 11th International conference of the European Association of Southeast Asia Archaeology*. Edited by Pautreau, J.P., Sophie, A., Zeitoun, V., and Rambault, E.

Forestier, H., 2010. *La pierre et son ombre : réflexion sur le phénomène hoabinhien d'Asie du Sud-est.* Habilitation à diriger des recherches. Université Paris Ouest Nanterre La Défense.

Forestier, H., Zeitoun, V. et al., 2013. The open-air site of Huai Hin (Northwestern Thailand): Chronological perspectives for the Hoabinhian. *Human palaeontology and prehistory* 12: 45-55.

Fox, R.B., 1970. "*The Tabon Caves*": Archaeological explorations and excavation on Palawan Island, Philippines., Monograph of the National Museum.

Fox, R.B., 1977. Leta-Leta Cave: The science and art of cave archaeology. In: A.R. Roces (Ed.) *Fihipino Heritage*. Manila. National Museum of the Philippines.

Fromaget, J. and Saurin, E., 1936. Note préliminaire sur les formations Cenozoic et plus récentes de la Chaîne Annamitique septentrionale et du Haut-Laos (stratigraphin, *prehistorie, anthropogie). Bulletin du Service Geoloqique de L'Indochine 22: 5-4* (in France).

Gaillard, C., Singh, M., Rishi, K., Bhardwaj, V., 2010b. Atbarapur (Hoshiarpur district, Punjab), the Acheulian of the Siwalik range within the south Asian context. Comptes Rendus Palevol. 9, 237-243.

Giallard, C., Singh, M., Dambricourt Malassé, A., 2011. Late Pleistocene to Early Holocene lithic industries in the southern fringes of the Himalaya. *Quaternary International*. Vol 299, pp. 112-122.

Giallard, C., Singh, M., Dambricourt Malassé, A., 2012. Hoabinhian in the Siwaliks of northwestern India? In: Tjoa-Bonatz, D., Reineck, A., Tjoa-Bonatz, M.L. (eds.), *Crossing Borders: Selected papers from the 13th International Conference of European Association of Southeast Asia Archeologists*. Singapore: NUS Press. pp. 13-35.

Gaillard, C., Singhb, M., Malasséa, A., Bhardwajb, V., Karirb, B., Kaurb, A., Surinder Palb, Anne-Marie Moignec, Cécile Chapon Saoa, Salah Abdessadoka, Julien Garganid, Alina Tudrynd., 2016. The lithic industries on the fossiliferous outcrops of the Late Pliocene Masol Formation, Siwalik Frontal Range, northwestern India (Punjab). *Human palaeontology and prehistory*. C.R. Palevol 15: 341-357.

Geneste, M., 1985. Analysis lithic d'industries moustériennes du Périgord : une approche technologique du comortement des groupes humains au Paléolithique moyen. Thesis, Université du Bordeaux.

Glover, I C., 1973. Late Stone Age traditions in South-East Asia. In South Asian Archaeology, edited by N. Hammond, pgs. 51-65. London: Duckworth.

Glover, I C., 1977. The Hoabinhian Hunter-Gatherers or Early Agriculture list in Southeast Asia; *Hunter Gatherers and First Farmer Beyond Europe*, J.V.S; Megaw; P. 148.

Glover, I., Bellwood, P., 2004. Southeast Asia from prehistory to history, Routedge Curzon Taylor& Francis Group.

Gorman, C.F., 1968. The Hoabinhian and after: Subsistence Patterns in Southeast Asia during the Late Pleistocene and Early Recent Periods. *World Archaeology* 2: 300-320.

Gorman, C.F., 1969. Hoabinhian: A pebble tool complex with early plant associations in Southeast Asia. *Science* 163, 671-673

Gorman, C.F., 1970. Excavation at Spirit Cave, north Thailand: Some interim interpretations. *Asia perspectives* 13: 79-107.

Gorman, C.F., 1971. The Hoabinhian and after: Subsistence pattern in Southeast Asia during the late Pleistocene and early recent period. *World Archeology*. No. 3, pp. 300-320.

Gorman, C.F., 1971b. Prehistoric Research in North Thailand: A culture chronographic sequence from the Late Pleistocene to Early Recent Period. *World Archeology*, 2, 300-320.

Gorman, C.F., 1972. Excavation at Spirit cave, North Thailand; *Asia Perspectives* 13:79-108.

Gorman, C.F and Charoenwongsa P., 1976. Ban Chiang: A Mosaic of Impression from the first two years. *Expedition* 18: 14-26.

Gorman, C.F., 1977. A priori models and Thai prehistory: A reconsideration of the beginnings of agriculture in southeastern Asia. In: Origins of Agriculture: 321-355, ed. C.A. Reed. The Hague: Mouton.

Grave, Peter., 1995. The shift to commodity: A study of ceramic producing and upland-lowland interaction in Northwestern Thailand. Ph.D. dissertation. University of Sydney, Australia.

Groube, L.M. et al., 1986. A 40,000-year old human occupation site at Huon Peninsula, Papua New Guinea. Where to now? *Late Papers, The Pleistocene Perspective*. The World Archaeology Congress, 1-7 September 1986. London: Allen and Unwin.

Hedges, R.E.M. et al., 1989. Radiocarbon dates from the Oxford AMS system: archaeometry datelist 9. *Archaeometry* 31: 207-234.

Heekeren van, H.R., 1957. The Stone Age of Indonesia. S-Gravenhage: Martinus Nijhoff.

Heekeren van, H.R., 1962. A brief survey of the Sai-Yok excavations, 1961-1962 season of the Thai- Danish Prehistoric Expedition. *Journal of the Siam Society* 50: 15-18.

Heekeren van, H.R. and C.E Knuth., 1967. Archaeological excavation in Thailand: *SAI-YOK, stone –ages settlement in the Kanchanaburi Province*; The Thai-Danish prehistory expedition 1960-62., Munksgaard, Copenhagen, Denmark.

Heekeren van, H.R., 1972. The Stone Age of Indonesia. Martinus Nijhoff, The Hague.

Heider, K. G., 1958. New Archaeological Discoveries in Kanchanaburi. *Journal of Siam Society* 45: 62-70.

Heider, K. G., 1960. A pebble- tool complex in Thailand. *Asian Perspectives* (1958) 2: 63-67.

Higham, Charles F.W., 1977. Economic Change in Prehistoric Thailand*; In Original of Agriculture; Edited by Charles A. Reed*; Mouton Publishers; P. 385-412.

Hutterer, K.L., 1976. An evolutionary approach to the Southeast Asian cultural sequence. *Current Anthropology* 17: 221-242.

Hutterer, K.L., 1977. *Reinterpreting the Southeast Asia Paleolithic*. In: J. Allen, J. Golson and R. Jones (eds*), Sunda and Sahul: Prehistoric Studies in Southeast Asia, Melaesia and Australia, pp. 567-600*. London: Academic Press.

Hutterer, K. L., 1985. People and nature in the tropics: Remarks concerning ecological relationships. *Cultural Values and Human Ecology in Southeast Asia* 27, 55-75.

Hutterer, K. L., 1987. Southeast Asia as a region: implications for archaeological theory, method, and practice. Appendix 7th of *SPAFA seminar*. In: *Prehistory of Southeast Asia (T-W11),* Pgs. 313-322. Bangkok, Surat Thani, Phangnga, Phuket, and Krabi, Thailand; 12-25 January 1987.

Inizan, M.L., Ballinger, M.R., Roche, H. and Tixier, J., 1999. Technology and terminology of Knapped stone., Nanterre: CRCP.

Intakosai, V. and Liere, W.J.V., 1978. A bifacial stone industry from Bo Ploi Thailand. *Modern Quaternary Research in Southeast Asia*, 5: 27-33.

Jamfoong, Wilawan., 1897. Debitage Analysis from Khao Talu, Ment and Heap Caves, Ban Kao Kanchanaburi. Unpublished BA Hornor Thesis, Silpakorn University, Bangkok. (in Thai)

Jérémie S., and Vacher S., 1992. Le Hoabinhian en Thailande, un example d'approche exprimentable. Bulletin de I' Ecole Franaise d' Extrme Orient, 79, 1 mm. 173-209.

Keeley, L.H., 1980. *Experimental determination of stone tool uses a microwear analysis*, The University of Chicago Press.

Kerr, A.F.O., 1924. "Notes on Some Rockpointing in lastorn Siam," *The Journal of the Siam Glloety*, Bangkok, 10, Part I.

Ketdhutat, Pthomrerk., 1987. Squeezing blood from stones. Paper presented at seminar in prehistory and archaeology of Northeastern Thailand. Udontani, Thailand, August 19-21, 1987.

Khaokhiew, C., 2003. Geoarcheology: Site formation processes of Tham Lod Rockshelter, Pang Mapha district, Mae Hong Son Province, Unpublished M.A Thesis. Department of Archeology, Silpakorn University. (in Thai)

Khaokhiew, C., 2004. Geoarchaeology of Tham Lod rockshelter, Changwat Mae Hong Son, Northern Thailand, Unpublished MA Thesis. Department of Geology, Faculty of Science, Chulalongkorn University.

Kheawtaya, C. 2005., Lithic analysis. In. Shoocongdej, Rasmi (Ed.), *Progress Report 3. Highland Archaeological Project in Pang Mapha Phase II*. Report submitted to Thailand Research Funds (TRF). (in Thai)

Khaewkamput, V., 2003. Archaeological at Tham Lod rockshelter: way of life of people in late Pleistocene- early Holocene. In: *Ancient Man, culture and Environment of the Highland in Pang Mapha, Mae Hong Son Province*. (ed. R. Shoocongdej). Proceeding of Ancient man, Culture and Environment of the Highland in Pang Mapha, Mae Hong Son Province. Organized by Department of Archaeology, Silpakorn University, 20-21. February 2003, pp. 60- 76. (in Thai)

Kiernan, K. et al., 1988. Prehistoric occupation and burial sites in the mountains of the Khong area, Mae Hong Son Province, northwestern Thailand. *Australian Archaeology* 27: 24-44.

Kiernan, K. et al., 1991b. Tropical Mountain Geomorphology and Landscape Evolution in Northwest Thailand. *Zeitschrift fÜr Geomorphologie NF*, 53, 187-206.

Kleindienst, M. R., 1961. Variability within the Late Acheulian assemblage in Eastern Africa. *The South African Archaeological Bulletin* 16 (62): 35-52.

Kleindienst, M.R., 1962. Components of the East African Acheulian assemblage: an analytic approach. In : *Actes du IVème Congrès Panafricain de Préhistoire et de l'Etude du Quaternaire*, vol. 40, ed. G. Mortelmans, 81–105. Tervuren : Musée Royal de l'Afrique Centrale.

Koch, K.E. and Siebenhuener, M., 1969. Some newly discovered Prehistoric sites in Northern Thailand; *Journal of the Siam Society*, 7 (2): 260-320.

Krajaejun, Pipad., 2001. The tree ring study of Long Coffin Cave: Case study in Ban Rai Rockshelter, Pang Mapha district, Mae Hong Province. B.A. Thesis. Silpakorn University, Bangkok. (in Thai).

Krajaejun, Pipad., 2007. Shell analysis. *The Final report of Highland Archeology Project in Pang Ma pha district, Mae Hong Son Province Phase II*, Submitted to Thai Research Funds (TRF). (in Thai)

Kukla, G., 1981. “Pleistocene climates on land.” In: *Climate Variation and Variability: Facts and Theories* (eds.) Berger, A.D. Reidel: Dordrecht. pp 207-232.

Kuhn, S.L., 1990. A geometric index of reduction for unifacial stone tools. *Journal Archaeological Science* 17 (5): 581-593.

Lao Yi Pa, S., and Tacumma, T., 2000. Forest in Kong River and Lang River Basin. In: Dilokwanich S., Kulparadit K., Siripornpibul C., Shoocondej R., Spies J., Chareonthong K., and Laoyipa, S. An exploration and data base system of the cave: Mea Hong Son Prvince: 69-84 pp. Submitted to Thailand Research Found (TRF). (in Thai)

Lao Yi Pa, S., 2000. *Characteristic of wild life in importance basin.* In: Dilokwanich S., Kulparadit K., Siripornpibul C., Shoocondej R., Spies J., Chareonthong K., and Laoyipa, S. An exploration and data base system of the cave: Mea Hong Son Prvince: 72-90 pp. Submitted to Thailand Research Found (TRF). (in Thai)

Leakey, Mary., 1971. *Olduvai Gorge: Excavations in Beds I & II 1960–1963*. Cambridge: Cambridge University Press.

Lekagul, B., and McNeely, J.A., 1988. Mammals of Thailand. 2th. Bangkok: Darnsutha Press.

Leroi-Gourhan, André, 1964. *Le geste et la parole*. Paris: Albin Michel. Tome I: *Technique et langage.*

Majid, Z., 1982. The Tampanian problem resolved: Archaeological evidence of the late Pleistocene lithic workshop. *Modern Quaternary Research in Southeast* Asia, Vol. 11, pp.71-96.

Majid, Z., 1982. The West Mouth, Niah, in the prehistory of Southeast Asia. *Sarawak Museum Journal* XXXI, No 52 New Series, Special Monograph No 3.

Majid, Z., and Tjia, H.D., 1988. Kota Tampan, Perak: The evidence geological & archaeological evidence for a late Pleistocene site. Journal of the Malasia Branch of the Royal Asiatic Society 61: 123-134.

Malaipan, Veeraphan, 1972. Paleolithic Tools from Chiang Sean. *Archaeology* 4 (in Thai).

Martin, Paul S., and Richart G. Klien, Eds., 1984. *Quaternary Extinction*: *A Prehistory Revolution*. The University of Arizona Press: Tucson.

Marwick, B., 2007. Approaches to Flaked Stone Artefacts Archaeology in Thailand: A History Review. Silpakorn University International Journal Vol. 7: pp. 49-88.

Marwick, B., 2008. Stone artefacts and human ecology at two rockshelters in Northern Thailand. Doctoral dissertation. Australian National University, Australia.

Marwick, B., 2008a. Beyon typologies: The reduction thesis and its implication for lithic assemblages in Southeast Asia. Bulletin of the Indo- Pacific Prehistory Association, 28: 108-116.

Marwick, B., 2008b. What attributes are important for the measurement of assemblage reduction intensity? Result from an experimental stone artefact assemblage with relevance to the Hoabinhian. Journal of Archaeology Science 35, 1189-1200.

Marwick, B., 2008c. Human behavioural ecology and stone artefacts in North-west Thailand during the terminal Pleistocene and Holocene In: Pautreau J.P., Coupey A.S., Zeitoun, V., Rambault, (Ed.), From Homo Erectus to The Living Tradition: Choice of papers from the 11th International Conference of European Association of Southeast Asia Archaeologists Bougon, 25th- 29th September 2006, Archaeology in Southeast Asia, pp.73-80.

Marwick, B. and Gagan, M.K., 2011. Late Pleistocene monsoon variability in northern Thailand: an oxygen isotope sequence from the bivalve Margaritanopsis laosensis excavated in Mae Hong Son province. Quaternary Science Review 30, 3088-3099.

Marwick, B., Shoocongdej, R., Thongcharoenchaikit, C., Chaisuwan, B., Khowkhiew, C. and Kwak, S., 2013. Hierarchies of engagement and understanding: Community engagement during archaeological excavations at Khao Toh Chong rockshelter, Krabi, Thailand. In O'Connor, S (ed.) Transcending the Culture-Nature Divide in Cultural Heritage: Views from the Asia-Pacific Region. Canberra: ANU E Press.

Matthews, J.M., 1961. *Checklist of Hoabinhian sites excavated in Malaya 1860-1939*. Singapore: Eastern University Press.

Matthews, J.M., 1964. The Hoabinhian in Southeast Asia and elsewhere. Doctoral dissertation. Canberra, Australian National University.

Matthews, J.M., 1966. The Hoabinhian affinities of some Australian assemblages. *Archaeology and Physical Anthropology in Oceania* 1: 5-22.

Matthews, J.M., 1969. A Review of the "Hoabinhian in Indo-China". *Asian Perspectives* 9: 86-95.

McBryde, I., 1976. Seelands and Sai-Yok pebble tools: a further consideration. *Australian Archaeology* 4: 58-73.

Mijares, A., Détroit, F. et al., 2010. New evidence for a 67, 000 years-old human presences at Collao cave, Luzon, Philippines. *Journal of Human Evolution* 59: 123-132.

Montelius, Oskar., 1903. Die Methode. In: *Die älteren Kulturperioden im Orient und in Europa* Vol I, pp. 15-43; 54-58. Stockholm.

Moser, J., 2001. *Hoabinhian Geographic and Chronologies eines steinzeitlichen Technokomplexes in Sudostasien*. Koln: Linden-Soft (in German).

Mourer, R., 1977. Laang Spean and the prehistory of Cambodia. *Modern Quaternary Research in Southeast Asia* 3: 29-56.

Mourer, C., and Mourer, R., 1970. The Prehistoric Industry of Laang Spean, Province of Battambang, Cambodia, Archaeology and Physical Anthropology in Oceania 5 (2): 128-47.

Mourer, C., and Mourer, R., 1973. Prehistoric research in Cambodia during the last ten years. *Asian Perspectives* (1971) 14: 35-42.

Movius, H.L., 1948. The Lower Palaeolithic Cultures of Southern and Eastern Asia. *Transactions of the American Philosphical Society* 38 (4): 329-420.

Movius, H.L., 1969. Lower Palaeolithic archaeology in southern Asia and the Far. In Early Man in the Far East: *a symposium of the American Association of Physical Anthropologists and the American Anthropological Association*, edited by W.W. Howells, pgs,17-81. The Netherlands: Osterhout N.B.

Natapintu, Surapol., 1987. Archaeology of central Thailand. In: *Archaeology of four regions*, edited by Fine Arts Departments, pp. 70-90. Hattasilpa Press. (in Thai)

Natapintu, Surapol., 1988. Current research on ancient copper-base metallurgy in Thailand. In: Prehistoric Studied: *The Stone and Metal Ages in Thailand*, (Ed.) Pisit Charoenwongsa and B. Bronson, pp. 107-124. Thai Antiquity Working Group, Bangkok.

Natapintu, Surapol., 1991. Archeometallurgy studies in the Khao Wong Prachan Valley, Central Thailand. *Bulletin of the Indo-Pacific Prehistory Association* 10: 153-160.

Nelson, M., 1991. The study of technological organization. In: *Archaeological Method and Theory* editing by M.B. Schiffer, pp. 57-100. University of Arizona, Tucson.

Nielsen, E., 1962. The Thai-Danish Prehistoric Expedition 1960-1962. *Journal of the Siam Society* 50: 7-14.

Nishimura, Masanari., 1994. Implication from regional variability and termination of the Hoabinhian industry: A Perspective from revising the present data. Paper presented at the 15th Indo-Pacific Prehistory Association Congress, Chiang Mai, Thailand, January 5-12, 1994.

Nguyen Kim Dong., 1994. The study of using traces on the stone tools of Xom Trai Cave (Hoa Binh Culure). Paper presented at Hoabinhian 60 years After Madeleine Colani Conference, Hanoi, Viet Nam, December 28, 1993-January 3, 1994.

Noll, M.P., 2000. *Components of Acheulian lithic assemblage variability at Olorgesailie, Kenya*. Unpublished Ph.D. Dissertation, University of Illinois at Urbana-Champaign.

Parr, Jonh, W.K., 2003. A guide to the large mammals of Thailand. Bangkok. *Sarakadee Press*. Thailand.

Pawlik, Alfred F., 2009. Is the function approach helpful to overcome the typology dilemma of lithic archaeology in Southeast Asia? *IPPA Bulletin 29*, pp. 6-14.

Pelegrin, J., C. Karlin and P. Bodu., 1988. *"Chaîne Opératoire" : un outil pour le prehistorien*. Technologie Prehistorique. Notes et Monographies Techniques. Editions du CNRS, Paris, 55-62.

Pelegrin, J., 1990. Prehistoric lithic technology: some aspects of research. *Archaeological review from Cambridge* 9(1): 116-125.

Penny, D., 2001. A 40,000 years palynological record from north-east Thailand: implication for biogeography and palaeo-environmental reconstruction. *Palaeogeography, Palaeoclimatology, Palaeoecology* 171, 97-128.

Perlès, C., 1992. In search of lithic strategies: A cognitive approach to prehistoric chipped stone assemblages, In: *Representations in Archaeology*, eds. J.C. Gardin and C.S. Peebles, 223-247. Bloomington: Indiana University Press.

Peterson, W., 1974. Summary report of two archeological sites from northeastern Luzon. Archaeological research in the Navaliches Watershed, Philippines. *Asian Perspectives* (1982) 22: 102-139.

Pholgerddee, P.C., 1981. Stone age tool cultures of western Thailand with Special reference to Kanchanaburi Province, Doctoral dissertation, Deccan college, Poona, India.

Pigeot, N., 1988. *Apprendre à débiter des lames: un cas d'éducation tehcnique chez des magdaleniens d'Etiolles.* Technologie Préhistorique. Notes et Monographies Techniques. Editions du CNRS, Paris, pp. 63-70.

Pookajorn, S., 1977. *Preliminary Report on Survey and Excavation in Ban Kao, Kanchanaburi during 1977 field Season*. Department of Archaeology, Silpakorn University. (in Thai)

Pookajorn, S., 1979. *Results of Scientific Analysis from Survey and Excavation of Stone Age Project in Ban Khao, Kanchanaburi*. Department of Archaeology, Silpakorn University. (in Thai)

Pookajorn, S., 1984. *The Hoabinhian of Mainland Southeast Asia: New Data from Recent Thai Excavation in the Ban Kao Area*. Bangkok, Thammasat University.

Pookajorn, S., 1985. Ethnoarcheology with the Phi Tong Luang (Mlabrai): Forest Hunters of Northern Thailand. *World Archeology*, 17, No.2, 206-221.

Pookajorn, S., 1986. Ethnoarchaeological Research on the hunting-gathering group in Thailand in comparison with the Hoabinhian Technocomplex: *A paper presented to the World Archaeological Congress at Southampton, England*, during 1-11 September, 1986.

Pookajorn, S., 1987. The Ethnoarchaeological Research among the Phi Tong Luang: *A Hunter- Gatherer Group and its Comparison with the Archaeology of the Hoabinhian Culture or Technocomplex. Final Report: Seminar in Prehistory of Southeast Asia*: 59-81. Southeast Asian Ministers of Education Organization, Bangkok.

Pookajorn, S., 1988. Archeological research of the Hoabinhian culture or technocomplex and its comparison with ethnoarcheology of the Phi Tong Luang, a hunter-gatherer group of Thailand, Doctoral dissertation, Tubingen, Verlag Archaeologica Venatoria: Institut fur Urgeschichte der Universitat Tubinge.

Pookajorn, S., 1991. *Preliminary Report of Excavation at Moh Khiew Cave, Krabi Province, Sakai Cave, Trang Province and Ethnoarchaeological Research of Hunter-Gatherer Group, So-Called "Sakai"or "Semeang"*. Bangkok: Department of Archaeology, Silpakorn University.

Pookajorn, S., 1994. *Final Report of Excavation at Moh Khiew Cave, Krabi Province, Sakai Cave, Trang Province and Ethnoarchaeological Research of Hunter-Gatherer Group, So-Called Mani or Sakai or Orang Asli at Trang Province. Vol 2.* Bangkok: Department of Archaeology, Silpakorn University.

Pookajorn, S., 2001. New perspective for Palaeolithic research in Thailand, pp. 167-187. In *Origin of Settlements and Chronology of the Palaeolithic Culture in Southeast Asia* (ed.) Sèmah, F., Falguéres, Hervé, D. G, Sémah, A.M, Semenanjung, Paris.

Pope, G. G., D. Feayer, M. Liangcharoen, P. Kulasing, S. Nakabanglang., 1981. Paleontological Investigations of Thai-American Expedition in Northern Thailand (1979-1980): An Interim Report. *Asian Perspectives* 12: 147-163

Pope G. G., 1989. Bamboo and human evolution. *Natural history 10*, 49-57.

Praehistorica Asiae Orientalis I., 1932. Premier Congres des Préhistoriens d'Extreme-Orient Hanoi (1932) : *Imprimerie d'Extreme-Orient*.

Prishanchit, S. & Pengtako, P., 1984. *Report on Reconnaissance Survey of the Obluang Site*. NTARP-2, vol.3, Northern Archaeological Research Project. Bangkok, Fine Arts Department. (in Thai)

Prishanchit, S., Pautreau, J.P., Santoni, M., 1985. *Preliminary Report 1985 Season, Survey and Excavation in Nan, Uttaradit and Obluang*, Thai-French Archaeological Project, Paris.

Prishanchit, S., 1988. A preliminary survey of lithic industries in Mae Hong Son, Nan, and Uttaradit, Northern Thailand. In: P. Charoenwongsa, and B. Bronson (eds). *Prehistoric studied*: *The Stone and Metal Ages in Thailand*, pp. 81-90. Bangkok: Thai Antiquity Working Group.

Pumijumnong, N., 2003. Palynological study from Ban Rai and Tham Lod Rockshelter archaeological site. In: *the conference on People, Culture and Paleoenvironment in Highland Pang Mapha, Mae Hong Son Province*, pp 317-339. Bangkok: Silpakorn University. (in Thai)

Pumijumnong, N. & Trikanchanawattana, C., 2006. Pollen over time: *The search for Holocene environments.* In: *Shoocongdej, R (ed.) Social, Culture and environmental Dynamic in the Highland of Pang Mapha, Mae Hong Son Province: Integrated Archeological Research into the Region*. Bangkok, Highland Archeology Project in Pang Mapha. (in Thai)

Pureepatpong, N., 1996. *Preliminary Analysis of human skeletal remains: a case study of S8 W22 Ban Mai Chaimongkol, Thambon Soi Tong Amphur Ta Cli, Nakornsawan Province*. B.A Thesis. Department of Archaeology, Silpakorn University, Bangkok. (in Thai)

Pureepatpong, N., 2004. Human osteological analysis. Progress Report 2. Highland Archaeological Project in Pang Mapha Phase II, submitted to Thailand Research Funds (TRF). (in Thai)

Pureepatpong, N., 2006. Recent Investigation of Early People (Late Plseistocene to Early Holocene) from Ban Rai and Tham Lod Rockshelter Sites, Pang Mapha, Mae Hong Son Province, Northwestern Thailand. In: Bacus E.A, Glover I.C, Pigott V.C., Unconvering Southeast Asia's Past: *Selected paper from the 10th International Conference of the European Association of Southeast Asia Archaeologists*, Singapore, National University of Singapore Press, pp.38-45.

Pyramarn, Kosum., 1989. New evidence on plant exploitation and environment during the Hoabinhian (Late Stone Age) from Ban Kao Caves, Thailand. In: *Foraging and Farming: The evolution of plane exploitation*, edited by D.R. Harris and G.C. Hillman, pp. 733. Unwin Hyman, London.

Rashid, H., Flower, B.P., Poore, R.Z., Quinn, T.M., 2007. A ~25 ka Indian Ocean monsoon variability record from the Andaman Sea. *Quaternary Science Review* 26, 2586-2597.

Reynolds, T.E.G., 1989. Techno-typology in Thailand: a case study of Tham Khao Khi Chan. *Indo-Pacific Prehistory Association Bulletin* 9: 33-45.

Reynolds, T.E.G., 1989. Problems in the Stone Age of Thailand. *Journal of the Siam Society forthcoming* (in press).

Reynolds, T.E.G., 1990. A Hoabinhian bibliography, In: *Bibliographical review of far eastern archaeology 1990*. Published by Oxbow book for East Asia archaeology new work.

Reynolds, T.E.G., 1992. Excavation at Banyan Valley Cave, Northern Thailand: A report on the 1972 season. *Asian Perspective,* 31:77-97.

Reynolds T. E. G., 1993. Problems in the Stone Age of South-East Asia. *Proceedings of the Prehistoric Society 59*, 1–15.

Reynolds T. E. G., 2007. Problems in the Stone Age of South-east Asia Revisited. *Proceedings of the Prehistoric Society 73*, 39–58.

Richardson, E., 2003. A geographical analysis of prehistoric sites in Pang Mapha. *Conference on People, Culture, and Paleoenvironment in Highland Pang Mapha, Mae Hong Son Province*. Silpakorn University, Bangkok.

Roche, H. and P.J. Texier., 1991. La notion de complexité dans un ensemble lithique : application aux séries Acheuléenes d´Isenya (Kenya). In : *25 Ans d´études Technologiques en Préhistoire*, 99–108. APDCA, Juan-les- Pins.

Roche, H. and P.J. Texier., 1995. Evaluation of technical competence of *Homo erectus* in East Africa during the Middle Pleistocene. In *Evolution and Ecology of Homo erectus,* eds. J.R.F. Bower and S. Sartono, 153–167. Leiden: Royal Netherlands Academy of Arts and Sciences. Pithecanthropus Centennial Foundation.

Rodriguez, X. P., 2004. Technical Systems of Lithic Production in the Lower and Middle Pleistocene of the Iberian Peninsula: *Technological variability between north-eastern sites and Sierra de Atapuerca sites,* BAR International Series 1323.

Ronquillo P. Wilfredo., 1981. The technological and functional analyses of lithic flake tools from Rabel Cave, Northern Luzon, Philippines, National Museum Manila, Philippines December 1981.

Royal Thai Survey Department., 1991. *Topographic map scale 1: 50,000, sheet 4648II, series L1708, edition 4-RTSD*. Bangkok: Royal Thai Survey Department.

Rundel, P.W & Boonpragob, K., 1995. Dry forest ecosystems of Thailand. In Bullock, S.H., Mooney, H.A.& Medina, E. (Eds.) *Seasonally Dry Tropical Forest*. Cambridge, UK., Cambridge University Press.

Sankalia, H.D., 1964. Stone age tools: *Their techniques, Names and Probable functions*., Deccan College, Postgraduate and Research Institute, Poona, India.

Santisuk, T., 1988. *An account of the vegetation of Northern Thailand,* Stuttgart, Franz Steiner Verlag.

Santoni, M., Pautreau, J.P., Prischanchit, S., 1985. *Preliminary Report 1985 Season, Survey and Excavation (Nan, Uttaradit and Obluang).* Paris: Thai-French Archaeological Project.

Santoni, M., Pauteau, J.P., and Prishanchit, S., 1986. *Preliminary Report, 1986 Season, Survey in Northern Thailand and Excavation at Obluang*. Paris: Thai French Archaeological Research Project.

Santoni, M., Pauteau, J.-P., and Prishanchit. S., 1990. Excavation at Obluang, Province of Chiang Mai, Thailand. In: Glover, I. & Glover, E. (Eds.) *Southeast Archaeology (1986). Proceeding of the first Conference of the Association of Southeast Asia Archaeologist in western Europe*. Institute of Archaeology, University College London. BAR. International Series S-561, pp. 37-54.

Sahnouni, M., K. Schick and N, Toth., 1997. An Experimental Investigation into the Nature of Faceted Limestone “Spheroids” in the early Paleolithic. *Journal of Archaeological Science* 24 (8): 701-713.

Sarasin, F., 1933. Prehistorical Research in Siam, *Journal of the Siam Society*, 26 (2): 171-202.

Sarasin, F., 1959. Prehistorical Researches in Siam, *Journal of the Siam Society*, 3: 101-132.

Sawatsalee, S., 1998. Rockshelter Art Painting Pang Mapha district, Mae Hong Son Province. B.A. Thesis. Silpakorn University, Bangkok. (in Thai)

Saurin, E., 1954. Outillage Hoabinhien a Giap Khau, Port-Courbet (Nord Viet Nam). *Bulletin de L’Ecole Francaise D’Extreme Orient* 48 : 581-592.

Sellet, F., 1993. *Chaîne opératoire* : the concept and its applications. *Lithic Technology* 18(1-2): 106 - 112.

Sieveking, A., 1960. The Palaeolithic industry of Kot Tampan, Perak northeastern Malaysia. *Asia Perspectives* (1958) 2:91-102.

Shoocongdej, R., 1990. Recent Research on Post-Pleistocene in The Lower Khwae Noi Basin, Kanchanaburi, Western Thailand. In: *Indo-Pacific Prehistory Assn. Bulletin 10, 1991: 143-149 (P. Bellwood ed., Indo Pacific Prehistory 1990, Vol 1).* Museum of Anthropology, University of Michigan, Ann Arbor, Michigan 48109, USA.

Shoocongdej, R., 1996. Forager mobility organization in seasonal tropical Environments, A view from Lang Kamnan Cave, Western-Thailand, Doctoral dissertation, University of Michigan, U.S.A.

Shoocongdej, R., 1996a. Working toward an Anthropological Perspective on Thai Prehistory: Current Research on the Post-Pleistocene. In: *Indo-Pacifice Prehistory Association Bulletin 14, pp. 119-132*. Museum of Anthropology, University of Michigan, Ann Arbor, Michigan 48109, USA.

Shoocongdej, R., 1996b. Forager Mobility Organization in Seasonal Tropical Environment: a View from Lang Kamnan Cave, Western Thailand. *Ann Arbor*: UMI.

Shoocongdej, R., 2000. Forager Mobility Organization in Seasonal Tropical Environment of Western Thailand. *World Archaeology*, 32, pp. 14-40.

Shoocongdej, R., 2000. The Final Report of Survey and Database of cave in Pang Mapha District, Mae Hong Son Province. Unpublished report presented to the Thai Research Foundation. (in Thai)

Shoocongdej, R. (Ed.), 2001. *Progress Report 2.* Highland Archaeological Project in Pang Mapha Phase I, Submitted to Thai Research Funds (TRF). (in Thai)

Shoocongdej, R. (Ed.), 2002. *Progress Report 4. Highland Archaeological Project in Pang Mapha Phase I*, Submitted to Thai Research Funds (TRF). (in Thai)

Shoocongdej, R. (Ed.), 2003. *Final Report 1. Highland Archaeological Project in Pang Mapha Phase I*, Submitted to Thai Research Funds (TRF). (in Thai)

Shoocongdej, R., 2003. Paleoenvironment during late Pleistocene to late Holocene on highland in Pang Mapha district, Mae Hong Son Province. *In the conference on People, Culture, and Paleoenvironment in Highland Pang Mapha, Mae Hong Son Province*. 20-21 February, 2002: 292-317 pp. Bangkok: Silpakorn University. (in Thai)

Shoocongdej, R. (Ed.), 2004. *Progress Report 4*. *Highland Archaeological Project in Pang Mapha Phase II*, Submitted to Thai Research Funds (TRF). (in Thai)

Shoocongdej, R., 2004. Preliminary report on the archaeological investigations of highland archaeology project in Pang Mapha (HAPP), Mae Hong Son Province, between 1998 -2004. *Southeast Asia Archeology International Newsletter*, January 2004, 6-8.

Shoocongdej, R. (Ed.), 2005. *Progress Report 3*. *Highland Archaeological Project in Pang Mapha Phase II*, Submitted to Thai Research Funds (TRF). (in Thai)

Shoocongdej, R., 2006. Late Pleistocene activities at the Tham Lod rockshelter in highland Pang Mapha, Mae Hong Son Province, Northwestern Thailand. In: Bacus, E.A. Grover, I.C., and Pigott, V (Eds.), *Uncovering Southeast Asia's past: selected papers from the 10th International Conference of the European Association of Southeast Asia Archaeologist*: 22-37 pp. Singapore: NUS press.

Shoocongdej, R. (Ed.), 2007. *Final report 2*. Highland Archaeological Project in Pang Mapha Phase II, Submitted to Thai Research Funds (TRF). (in Thai)

Shott, M.J., 2003. *Chaîne opératoire* and reduction sequence. *Lithic Technology* 28 (2): 95-105.

Singh, M. and Gaillard, C., 2008. "Square tools" from the Siwaliks of Northern western India: flat choppers, axes,adzes? In: *Prehistoric Investigation in Siwalik Frontal Ranges of Punjab (Past II). Between Jaijon-Doaba and Roopnagar*. Project sponsored by the Govt. of Punjab, Department of Cultural Affairs, Archaeology and Museums, Society for Archaeological and Anthropological Research, Chandigarh.

Sinsakul, Sin., 1987. Quaternary geology and sea-level changes in the area o Phangnga and Krabi: implications for prehistoric archaeology. Appendix 7th of *SPAFA seminar* In: *Prehistory of Southeast Asia (T-W11)*, Pgs. 313-322. Bangkok, Surat Thani, Phangnga, Phuket, and Krabi, Thailand; 12-25 January 1987.

Sinsakul, Sin.,1991. Evidence of sea level changes in the coastal area of Thailand: A review; *Workshop on Global environment changes; The role of the Geoscientist, past, present, and future sea level changes*. Chiang Mai, Thailand. pp.30.

Snow, B.E. et al., 1986. Evidence of early rice agriculture in Philippines. *Philippine Quarterly of Culture and Society* 14: 3-11.

Solheim, W.G., 1970. Northern Thailand, Southeast Asia, and World prehistory. *Asian Perspectives*, XIII, pp. 145-162.

Solheim, W.G., 1972a. Northern Thailand, Southeast Asia and World Prehistory. *Asian Perspective* (1970)13: 145-162.

Solheim, W.G., 1972b. The “new look” of southeast Asia prehistory. *Journal of the Siam Society* 60: 1-20.

Solheim, W.G., 1974. The Hoabinhian and Island Southeast Asia; *Proceedings of the First Regional Seminar on Southeast Asian Prehistory and Archaeology in 1972*. National Museum of the Philippines, Minila, pp. 19-26.

Solheim, W.G., 1975. Reflection on the new data of Southeast Asia prehistory: Austronesian origin and consequences. *Asian Perspectives* (1975) 18: 146-160.

Sophady, H., Forestier, H., Zeitoun, V., Puaud, S., Frère, S., Celiberti, V., Westaway, K., Mourer, R., Than, H., Billault, L., 2015. Hoabinhian in Cambodia: the tale of Laang Spean Cave. *Quaternary International* (in press).

SØrensen, P. and T. Hatting., 1967. *Archeological Excavations in Thailand*. Munkgaad, Copenhagen.

SØrensen, P., 1974. Prehistoric iron implement from Thailand. *Asian Perspectives* 16 [2 (1973)]: 134-73.

SØrensen, P., 1976. Preliminary Note on the Absolute and Relative Chronology of Two early Plaeolithic Sites from Northern Thailand. In: A.K Ghosh., *Le Pale´olithique Infe´rieur et Moyen en Inde, en Asie Centrale, en Chine dans le Sud-Est Asiaque*. 11th Congress, International Union of Pleistoric and Protohistoric Sciences, Nice.

SØrensen, P., 1979. Preliminary note on the relative and absolute chronology of two early Paleolithic sites from North Thailand. In: *Le Paleolithique Inferior Moyen, en Asie Centrale, en Chine et dans le Sud-East Asiatique.* U.I.S.S.P: Nice, either by A.K. Ghosh, pgs. 237-251.

SØrensen, P., 1982. Hoabinhian and woodworking in Thailand, A research paper in Anthropology for MSC., University of Pennsylvania.

SØrensen, P., 1988. Archeological excavation in Thailand: *Surface finds and minor excavations*, Scandinavian Institute of Asia Studies Occasional Papers No.1, Curzon press.

Soressi, M. and J.M. Geneste., 2011. Reduction sequence, *chaîne opératoire*, and other methods: the history and efficacy of the *chaîne opératoire* approach to lithic analysis: studying techniques to reveal past societies in an evolutionary perspective. Paleoanthropology, 334-350.

Srikosamart, S., Noasawasd, S., Lao Yi Pa, S., and Suteethorn, V., 1999. Status of salt earth and wildlife in Mae Hong Son province and the potential for supporting eco-tourism. In: *Resulting report for development of knowledge and studding the policy of biological research management in Thailand*. (Ed.) Shoocongdej Rasmi (2003b). Paleoenvironment during late Pleistocene to late Holocene on Highland Pang Mapha. In: *Conference on people, Culture and Paleoenvironment in Highland Pang Mapha, Mae Hong Son Province*, pp 292-317. Bangkok. Silpakorn University. (in Thai).

Srisuchat, A., 1987. Prehistoric cave and some important prehistoric sited in Southern Thailand. *In Appendix 4 of SPAFA Seminar in prehistory of Southeast Asia (T-Wll),* pgs. 103-117. Bangkok, Surat Thani, Phangnga, Phuket and Krabi, Thailand; 12-25 January.

Tan, Ha Van., 1979. The Hoabinhian in the Context of Vietnam; *Vietnamese Studies*; pp. 127-197.

Tan, Ha Van., 1980. Nouvelles recherches préhistoriques et protohistoriques au Vietnam. *Bulletin de L'Ecole Française D'Extrême Orient* 68: 113-154. (in France)

Tan, Ha Van., 1985. The late Pleistocene climate in Southeast Asia: new date from Vietnam. *Modern Quaternary Research in Southeast Asia* 9: 81-86.

Tan, Ha Van.,1988. Different lines of post-Hoabinhian cultural development in the Stone Age in Vietnam, Paper presented at the Second International Conference of the Association of Southeast Asian Archaeologists in Western Europe, 19-23, September 1988, Paris.

Tan, Ha Van., 1997. The Hoabinhian and before. Bulletin of the Indo-Pacific Prehistory Association 16-3: 35-41.

Thaw, U Auang., 1973. The 'Neolithic' culture of the Padah-lin caves. Asia Perspectives (1971) 14: 123-133.

Teilhard de Chardin, P., 1950. Le Paleolithic du Siam. *L'Anthropologie*, 54: 547-549.

Testart A., 1977. Ethnologie de l'Australie et Préhistoire de l'Asie du Sud-est. *JSO (Journal de la Société des Océanistes) 33,* 77–85.

Texier, P.J. and H. Roche., 1992. The impact of predetermination on the development of some Acheulian chaînes opératoires. In: Evolución Humana en Europa y los Yacimientos de la Sierra de Atapuerca, Vol 2., eds. J.M. Bermúdez de Castro, J.L. Arsuaga and E. Carbonell, 403–420. Valladolid : Junta de Castilla y León.

Texier, P.J., 1995. The Oldowan assemblage from NY 18 Site at Nyabusosi (Toro-Uganda). Comptes Rendus de l'Academie des Sciences Paris 320: 647–653.

Texier, P.J. and H. Roche., 1995. Polyèdre, sub-sphéroïde, sphéroïde et bola: des segments plus ou moins longs d'une même chaîne opératoire. Cahier Noir 7 : 31-40.

The remote sensing and geo-informatic system., 1998. *Draft final report: Application of remote sensing data and GIS for monitoring forest landuse change in um-Nam Pai Wildlife sanctuary*. Chiang Mai. The remot sensing and geo-informatics system, Geography, Faculty of Social, Chiang Mai University. (in Thai)

Thipkamjornwong, S., 1997. Master thesis "The function morphology analysis of lithic samples: A case study from Archaeological excavation Moh Khiew Rockshelter II, Amphoe Muang, Krabi province, Silpakorn university, Thailand. (inThai).

Thosarat R., 1982. *Hoabinhian and woodworking in Thailand.* Master Thesis. University of Pennsylvania.

Tiauzon, A., 2010. Master dissertation "*Lithic technology in Song Terus during the Late Middle Pleistocene and the Early Upper Pleistocene*" Department of prehistory in the National Museum of Natural History (MNHN), Paris, France.

Tixier, J., 1956. Le hâchereau dans l'Acheuléen Nord-Africain : notes typologiques. In *Congrès préhistorique de France – Compte-rendu de la XVème session, 15–22 July*, 914–923. Poitiers : Angoulême.

Tixier, J., 1978. *Méthode pour l'étude des outillages lithiques* : notice sur les travaux scientifiques de J. Tixier. Université de Paris X Nanterre.

Tixier, J., 1996. Technologie et typologie : dérives et sclérose, Quaternaria Nova, 6, pp. 15-21.

Treekanchanawattana, C. and Pumijumnong, N., 2005. Palynological analysis. In: Rasmi (Ed.), *Progress Report 4*. Highland Archaeological Project in Pang Mapha Phase II, Submitted to Thai Research Funds (TRF). (in Thai)

Treekanchanawattana, C., 2007. Dendrology and environment. *Final Report*. Highland Archaeological Project in Pang Mapha Phase II, Submitted to Thai Research Funds (TRF). (in Thai)

Treerayapiwat, C., 1998. The Location Study Log Coffin Cave in Pang Mapha district, Mae Hong Son Province. B.A thesis. Silpakorn University, Bangkok. (in Thai)

Treerayapiwat, C., 2005. Pattern of the Habitation and Burial activity in Ban Rai rockshelter, North-western Thailand. *Asian Perspectives*, 44: 231-245.

Van Heekeren, H.R., 1947b. Stone Age Discoveries in Siam, 1943-1944, pps, 2, pp.24-32.

Van Heekeren, H.R., 1957. The Stone Age of Indonesia. S-Gravenhage: Martinus Nijhoff.

Van Heekeren, H.R., 1962. A brief survey of the Sai-Yok excavations, 1961-1962 season of the Thai- Danish Prehistoric Expedition. *Journal of the Siam Society* 50: 15-18.

Van Heekeren, H.R., and C. E Knuth., 1967. *Archaeological excavation in Thailand, Vol.1: Sai-Yok. Stone Age Settlements in the Kanchanaburi Province*, Compenhagen: Munksgaard.

Van Vlack, H G., 2014. *Forager Subsistence Regimes in the Thai-Malay Peninsula: An Environmental Archaeological Case Study of Khao Toh Chong Rockshelter, Krabi*. Available from ProQuest Dissertations & Theses A&I. (1622150080).

Vaufrey, R., 1927. Découverte d'industries préhistoriques à Sumatra et dans la presqu'île de Malacca. *L'Anthropologie* 37 : 299-239.

Walker, D and Sieveking., 1962. The Paleolithic industry of Kota Tampan, Perak, Malaysia. *Proceeding of the Prehistoric Society*, No 6, pp. 103-139.

Wangwacharakul, V., Ratanaseampong, S., Nabhitabrata, J., Jintanayon, S. and Trisurat, Y., 2000. *Biological resource values in Mae Hong Son Province*. Biological Resources section, National resource and Environmental Management Division, Office of Environmental policy and Planning (OEPP). (in Thai)

Wannasri Sineenart., 2004. A dendroarchaelogoical, Study of log Coffins: Bo Krai Cave and Ban Rai Rockshelters in Pang Mapha District, Mae Hong Son Province. Master dissertation. (Technology of Environmental Management) Faculty of Graduate Studies Mahidol University.

Wattanapituksakul, S., 2006. Late Pleistocene mammal teeth from Tham Lod Rockshelter, Amphoe Pang Mapha, Changwat Mae Hong Son. MA Thesis, *Department of Geology*. Bangkok, Chulalongkorn University.

White, J.P., 1977. Crude colourless and unenterprising? Prehistorians and their views on the stone age of Sunda and Sahul. In: *Sunda and Sahul: prehistoric studies in Southeast Asia, Melanesia and Australia*, edited by J. Allen; J. Golson and R. jones, pgs 13-30. London: Academic Press.

White, J.C. and Gorman, C.F., 1979. Patterns in "amorphous" industries: the Hoabinhian viewed through a lithic reduction sequence. Paper presented at the 44th annual meeting of the Society for American Archaeology, Vancouver, British Columbia, 23-25 April 1979.

White, J.C. and Gorman, C.F., 2004. Pattern in "amorphous" industries: the Hoabinhian viewed through a lithic reduction sequence. In: Paz, V. (Ed.) *Southeast Asia Archaeology: Wilhelm G. Solheim II Festschrift*. Quezon City, University of the Phillipines Press.

White, J.C., 2011. Emergence of cultural diversity in mainland Southeast Asia: a view from prehistory. In: Enfield, N.J. (Ed.), *Dynamics of Human Diversity: The Case of Mainland Southeast Asia*. Pacific Linguistics, Canberra, pp. 9–46.

WWW Thai program office., 2000. *Mammals in Thai and Indochina*, Bangkok: Bangkok Press. (1984) Limited. (in Thai)

Xhauflair, H., 2014. Plant Use in the Subsistence Strategies of Prehistoric Huntergatherers in Palawan Island Assessed from the Lithic Industry. Building up a Reference Collection (PhD thesis). Museum national d'Histoire naturelle, France.

Xhauflair, H., Pawlik, A., Gaillard, C., Forestier, H., Vitales, T., Callado, J.R., Tandang, D., Amano, N., Manipon, D., Dizon, B., 2015. Characterisation of the use-wear resulting from bamboo working and its importance to address the hypothesis of the existence of a bamboo industry in prehistoric Southeast Asia. *Quaternary International* (in press).

Xueping Ji, Kathleen Kuman, R.J. Clarke, Hubert Forestier, Yinghua Li, Juan Ma, Kaiwei Qiu, Hao Li, YunWu., 2015. The oldest Hoabinhian technocomplex in Asia (43.5 ka) at Xiaodong Rockshelter, Yunnan Province, southwest China. *Quaternary International* (in press).

Yen, D.E., 1977. Hoabinhian horticulture? The evidence and the questions from northwest Thailand. In: *Sunda and Sahul: Prehistoric Studies in Southeast Asia, Melanesia and Australia*: 567-599, ed. J. Allen, J Golson, and R. Jones. London. Academic Press.

You-Di, Chin., 1978. History of Prehistoric Archaeology in Thailand, Department of Archaeology, Silpakorn University, Bangkok, Thailand.

You-Di, Chin., 1986. Collective Papers of Chin You-Di. Pikanesa Press, Bangkok (in Thai).

Zeitoun, V., Forestier, H., Nakbunlung, S., 2008. Préhistores au Sud du Triangle d’Or. Editions IRD, Bondy, 252 p.

Zeitoun V., Forestier H., Rasse M., Auetrakulvit P., Kim J., Tiamtinkrit C., 2013. The Ban Don Mun artifacts, a chronological reapraisal of human occupation in the Lampang province of Northern Thailand. *Journal of Human Evolution* 65, pp. 10-20.